SCIENCE

21 June 1957

Volume 125, Number 3260

Editorial Scientific Information Please! 1229

Articles Pulmonary Circulation: *A. Cournand* 1231

C.-E. A. Winslow, Leader in Public Health: *J. F. Fulton* 1236

News of Science News Articles and Briefs; Scientists in the News; Recent Deaths 1237

Reports Effect of "Tranquilizing" Drugs on Amphetamine Toxicity in Aggregated Mice: *L. Lasagna* and *W. P. McCann* 1241

Some Factors Affecting Fluorescence Maxima: *D. M. Hercules* 1242

Formation of Gibbsite Aggregates in Latosols Developed in Volcanic Ash: *G. D. Sherman* 1243

Preparation and Properties of Antihuman Properdin Rabbit Serum: *L. Pillemer, C. F. Hinz, Jr., L. Wurz* 1244

Graded Collodion Membranes for Separation of Small Molecues: *C. W. Carr, D. Anderson, I. Miller* 1245

Liver Catalase and Tumor Inhibition by Urinary Extracts: *C. B. Brown* and *C. L. Walters* 1246

Water Taste in *Phormia: M. L. Wolbarsht* 1248

Equilibria as Origin of Differences in Spectra of Chlorophyll in Different Solvents: *S. Freed* 1248

Book Reviews *A First Course in Analytic Geometry; The Great Chain of Life; Chemical Engineering in the U.S.A.; Electrical Measurements and Their Applications; Breads, White and Brown; Methods in Enzymology*; New Books; Miscellaneous Publications 1250

Meetings and Societies Nerve Cells; Society Elections; Forthcoming Events 1253

Letters 1260

Equipment News 1262

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

NEW ACADEMIC PRESS BOOKS

BIRKHOFF, G., and ZARANTONELLO, E. H.
Jets, Wakes, and Cavities
March 1957, 353 pp., illus., $10.00

Coordinating vital ideas into a whole and shedding light on numerous problems of hydraulics and aeronautics, this volume reports systematically the most important findings of nearly 100 years of ingenious research in the fascinating and complex field of jets, wakes, and cavities.

BOOTH, A. D., and
BOOTH, KATHLEEN, H. V.
Numerical Methods
Second Edition
Summer 1957, 195 pp., illus., $6.50

This new edition is written for those who wish to acquire the art of programming and preparing problems for an automatic digital calculator, for which a thorough knowledge of the underlying mathematical principles is essential, but where the actual details of calculation are carried out automatically.

BRACHET, J.
Biochemical Cytology
July 1957, about 480 pp., illus., $8.80

Addressed to all who, familiar with the fundamentals of descriptive cytology, biochemistry, embryology, and genetics, seek a systematic and unified presentation of the development of scientific knowledge in these fields.

BRAY, H. G., and WHITE, K.
Kinetics and Thermodynamics in Biochemistry
May 1957, 343 pp., illus., $7.50

In this book the theory underlying aspects of kinetics and thermodynamics is developed systematically and illustrated with examples of their application to biochemical and biological problems.

BROWN, MARGARET E. (ed.)
The Physiology of Fishes
Volume 1. METABOLISM
May 1957, 447 pp., illus., $12.00
Volume 2. BEHAVIOR
July 1957, about 535 pp., illus., approx. $12.50
Ten per cent price reduction on orders for complete set

Each chapter of this two-volume work correlates material scattered over many publications, reviews existing knowledge and theories, and indicates those directions in which future research may lead to important results.

COLLINS, R. B. (ed.)
High-Speed Photography
March 1957, 417 pp., illus., $13.00

Containing the proceedings of the 3rd International Congress on High-Speed Photography held in London, 1956, this volume describes techniques and applications not otherwise available in the published literature.

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COLOWICK, S. P., and
KAPLAN, N. O. (eds.)
Methods in Enzymology
Volume IV: SPECIAL TECHNIQUES
Summer 1957, about 930 pp., illus., approx. $22.00

This four-volume work presents, for the first time in the English language, a comprehensive collection of the methods used in the study of enzymes.

COOK, A. H. (ed.)
The Chemistry and Biology of Yeasts
Summer 1957, about 650 pp., illus.

Academic mycologists, microbiological chemists, biochemists, and industrial researchers will find that this comprehensive treatment with its thorough literature coverage provides a major work of reference as well as a detailed reflection of past and particularly of recent research in the many diverse fields associated with yeasts of widely different characteristics.

CREMER, H. W. (ed.)
Chemical Engineering Practice
Complete in 12 volumes plus index volume
Volume 3. SOLID SYSTEMS
March 1957, 552 pp., illus., $17.50 (non-subscription price)

Subscription price, $13.30 per volume, applicable on orders for complete set.

DESTY, D. H. (ed.)
Vapour Phase Chromatography
March 1957, 436 pp., illus., $12.00

The thirty-four papers contained in this volume were presented at the 1956 London Symposium on Vapour Phase Chromatography, organized by the Hydrocarbon Research Group of the Institute of Petroleum.

FILCHNER, W., PRZYBYLLOK, E., and
HAGEN, T.
Route-Mapping and Position-Locating in Unexplored Regions
April 1957, 288 pp., illus., $9.00

This book discusses the available methods by which the traveller can make the necessary surveys for so-called route maps during his journey.

GRÖNWALL, A.
Dextran and Its Use in Colloidal Infusion Solutions
April 1957, 156 pp., illus., $4.00

This monograph traces the development of the use of dextran as the colloid osmotic active component in colloidal infusion solutions and plasma expanders and summarizes the literature on its medical use during the first decade of its practical application.

HELLER, H. S. (ed.)
The Neurohypophysis
March 1957, 275 pp., illus., $9.50

This volume contains the proceedings of the Eighth Symposium of the Colston Research Society, held at the University of Bristol.

HOAGLAND, H. (ed.)
Hormones, Brain Function, and Behavior
March 1957, 257 pp., illus., $7.00

The papers and discussions contained in this volume represent the proceedings of a Conference on Neuroendocrinology held at Columbia University's Arden House, Harriman, New York, 1956.

KAMEN, M. D.
Isotopic Tracers in Biology
AN INTRODUCTION TO TRACER METHODOLOGY
Third Edition, revised, enlarged, and reset
June 1957, 474 pp., illus., $9.50

Written mainly from a biochemical standpoint, this new edition will serve as a valuable introduction to the important field of isotopic tracers and methodology for all biologists, whether biochemists, physiologists, or clinicians.

KAUZMANN, W.
Quantum Chemistry
AN INTRODUCTION
January 1957, 744 pp., illus., $12.00

Explains the principles of quantum mechanics and describes the major achievements derived from their applications to chemistry. Atomic and molecular systems are treated in detail, and special emphasis is given to various interactions between matter and light, such as absorption, emission, scattering, reflection, and optical rotation.

KLEIN, L.
Aspects of River Pollution
March 1957, 621 pp., illus., $14.50

Intended particularly for those directly concerned with anti-pollution work, such as government departments, river boards, local authorities, and manufacturers, this book will also be of interest to public analysts, sanitary inspectors, engineers, and public health authorities.

KLOTZ, I. M.
Some Principles of Energetics in Biochemical Reactions
April 1957, 64 pp., illus., $3.00

Prepared especially for biochemists, physiologists, and biologists interested in the molecular bases of biological phenomena, the book contains a brief and clear exposition of the essential concepts of energetics and assumes for mathematical background only the principles of arithmetic.

January-Summer 1957

LINSTEAD, R. P., and WEEDON, B. C. L.
A Guide to Qualitative Organic Chemical Analysis
January 1957, 169 pp., illus., $4.50
The inclusion of a number of advanced methods and tests for the detection and characterization of organic compounds makes this book of great practical use to graduate students and research workers in chemistry.

MANDL, F.
Quantum Mechanics
Second Edition
August 1957, about 250 pp., illus., $6.50
Provides students and experimental researchers with a thorough grasp of quantum mechanics, enabling them to perform quantum mechanical problems and to read the theoretical literature, without demanding a previous high standard of mathematical knowledge.

MEISTER, A.
Biochemistry of the Amino Acids
June 1957, 485 pp., illus., $10.00
Intended to give a thorough and comprehensive picture of the present state of knowledge concerning the biochemical interrelationships and transformations of the eighty or more naturally occurring amino acids.

MILTHORPE, F. L. (ed.)
The Growth of Leaves
Proceedings of the Third Easter School of Agricultural Science, University of Nottingham, 1956
March 1957, 223 pp., illus., $6.80
The purpose of this school was to provide a forum for discussion among specialists in leaf growth.

PIGMAN, W. (ed.)
The Carbohydrates
CHEMISTRY, BIOCHEMISTRY, PHYSIOLOGY
Summer 1957, about 930 pp., illus., prepublication price, $18.00
This one-volume work summarizes in one convenient source the great mass of literature up to the year 1956, integrates chemical and biological aspects, and reflects the important position of the carbohydrates in the processes of life.

Plant and Process Dynamic Characteristics
Proceedings of a Conference held in Cambridge, England, April 1956, by the Society of Instrument Technology
April 1957, 246 pp., illus., $8.80
The papers establish the facts about existing plants and processes and suggest new methods of designing plants and controlling processes so that the quality of the product is improved or the efficiency of the plant increased.

PIETERS, H. A. J., and CREYGHTON, J. W.
Safety in the Chemical Laboratory
Second Edition, revised and enlarged
April 1957, 258 pp., illus., $7.50
Intended primarily for laboratory workers and students, this volume outlines the potential hazards and shows in clear, precise language how they may be combatted successfully by taking precautionary measures and using appropriate equipment.

Plant Protection Conference 1956
Proceedings of the Second International Conference, Fernhurst Research Station, England
April 1957, 315 pp., illus., $9.00
This volume sheds light on the achievements of the geneticists in relation to the breeding of crop varieties resistant to disease, on the commercial usage and potentialities of systemic materials, the safe use of chemicals from the viewpoint of the worker applying them, and on the mammalian toxicity of new crop-protection products.

REBUCK, J. W., BETHELL, F. H., and MONTO, R. W. (eds.)
The Leukemias
ETIOLOGY, PATHOPHYSIOLOGY, AND TREATMENT
April 1957, 711 pp., illus., $13.00
This volume contains the proceedings of an International Symposium on "The Leukemias: Etiology and Pathophysiology" held at the Henry Ford Hospital, Detroit, 1956.

REID, C.
Excited States in Chemistry and Biology
June 1957, 215 pp., illus., $7.50
It is the object of this book to outline some of the more important physical concepts concerning molecular excitation and interaction, and to apply them to a few chemical and biochemical situations.

ROBERTSON, A. J. B. et al.
Laboratory Glass-Working for Scientists
April 1957, 200 pp., illus., $4.00
This manual has been compiled to help scientists with the problems of glass-working. By avoiding the more difficult manipulations involved in professional glass-working, it is possible for the scientist to assemble quite complex apparatus, including, for example, his own diffusion pumps, mass spectrometer tubes, molecular beam generators, and silica fibers.

ROFF, W. J.
Fibres, Plastics, and Rubbers
A HANDBOOK OF COMMON POLYMERS
January 1957, 400 pp., illus., $10.00
Contains extensive chemical, physical, and general information on common high polymers, i.e., on materials composed of relatively simple recurring units which give rise, in aggregation, to unique properties and find important technical applications in the shape of fibres, films, plastics, and rubbers.

SCHNITZER, R. J., and GRUNBERG, E.
Drug Resistance of Microorganisms
April 1957, 395 pp., illus., $10.00
A timely, comprehensive presentation of the phenomenon of drug resistance in all its experimental facets. The description of experimental observations is accompanied by discussions of theoretical concepts which involve chemical, biochemical, and predominantly biological aspects of the problem and the use of drug resistance as a tool in the field of microbiology.

SJÖSTRAND, F. S., and RHODIN, J. (eds.)
Electron Microscopy
July 1957, about 400 pp., 7" x 10", 488 figs., approx. $17.50
This volume contains the text of 137 papers presented to the First European Regional Conference on Electron Microscopy, Stockholm, September 1956.

SZENT-GYÖRGYI, A.
Bioenergetics
April 1957, 143 pp., illus., $4.50
The author presents his concepts of the ways in which energy supports the living systems. If extended and corroborated, these views may well influence biological and medical thinking by opening new experimental approaches to central problems in these areas of science.

THOMPSON, R. H. S., and KING, E. J.
Biochemical Disorders in Human Disease
July 1957, 842 pp., illus., $12.60
Assembles, relates, and interprets the known facts concerning the biochemical disorders that underlie or are associated with human disease. It is hoped that both biochemists and physicians will find this volume a useful source of material which will help them to understand the scientific background of present-day medicine.

WYLLIE, M. R. J.
The Fundamentals of Electric Log Interpretation
Second Edition, revised and reset
January 1957, 176 pp., illus., $4.50
Contains an amplification and simplification of material covered in the first edition; it also includes new sections on nuclear and acoustic logging.

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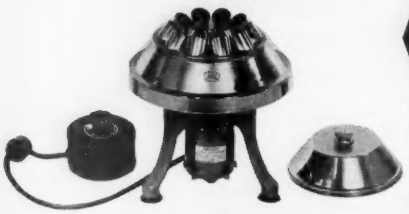

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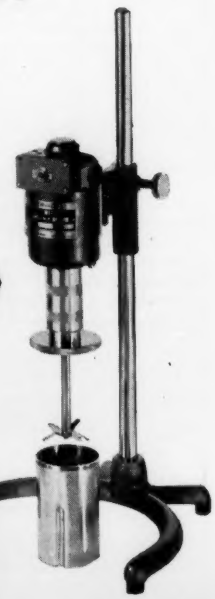

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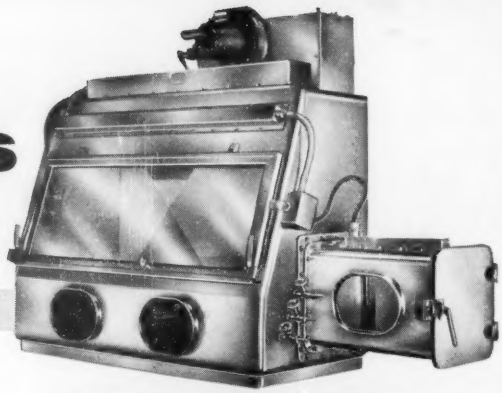

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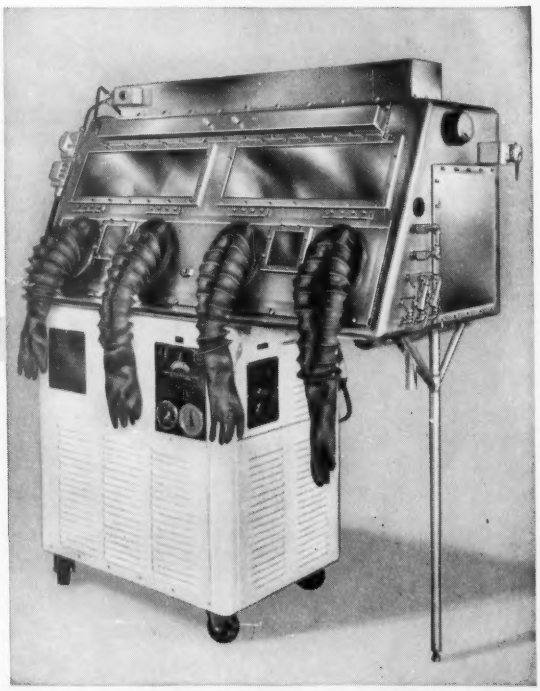

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Scientific Information Please!

An international conference on the problems of search and retrieval of scientific information will be held in Washington, D.C., in November 1958, under the sponsorship of the National Academy of Sciences–National Research Council, the National Science Foundation, and the American Documentation Institute, and with the cooperation of the Royal Society, the International Council of Scientific Unions, UNESCO, the International Federation of Documentation, and other organizations.

The exponential rate of increase of our scientific knowledge, as measured by the amount recorded in published media, has given new significance to the old questions of how to store, classify, and index information so that reasonably complete retrospective search and retrieval may be made easily. Because of the urgency, in a technologic society, of putting new knowledge to work, industry and government as well as scientists are concerned with the acute problems of storage and retrieval.

The Royal Society's Scientific Information Conference, held in London in 1948, focused international attention on a wide range of problems of our scientific literature, including prominently those of storing and retrieving information. Since that time, some of the conclusions and recommendations of the conference have been put into effect, some are only now being implemented, and some have been put aside as impractical. Several discussions of the subject have been held since then, the most recent being those sponsored by the School of Library Science at Western Reserve University and a number of industrial, academic, and professional organizations. The need for another examination at an international level of the basic aspects of the search and retrieval problem has been increasingly apparent.

The 1958 Washington Conference will be devoted to critical analysis and discussion of recent or current research throughout the world on techniques, mechanisms, systems, organization, and theory for the storage of and retrospective search for information, and to the distribution of responsibility for further research and development in this field. Discussion will be based on papers dealing with either specific or general aspects prepared by users, scientists, and documentalists who have been concerned with the problems. Matters concerned with primary publication will be considered only incidentally.

Papers contributed for the conference will be selected by referee panels coordinated by a program committee. Accepted papers will be printed and distributed to the participants in advance; they will not be formally presented at the conference by their authors. Sessions will be used for discussion and analysis by panels of participants.

The Conference Committee is anxious to receive as soon as possible suggestions or outlines from individuals or groups who have studies in progress or definitely planned which may serve as a basis for a contribution to the program. Inquiries should be directed to Dr. Alberto Thompson, Executive Secretary, International Conference on Scientific Information, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C.

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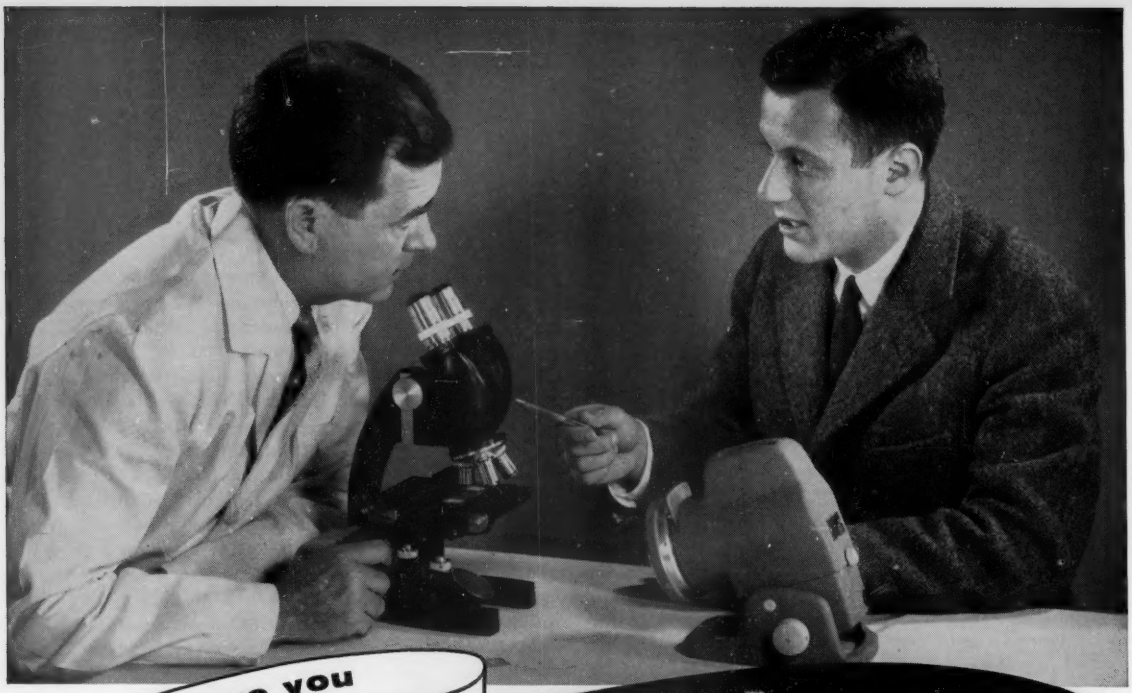

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21 June 1957, Volume 125, Number 3260 SCIENCE

Pulmonary Circulation

Its Control in Man, with Some Remarks on Methodology

A. Cournand

The development of our knowledge of the pulmonary circulation in man has followed the introduction of the cardiac catheter into clinical investigation. In 1943, this new tool was only the key in the lock—although this is in no way to minimize W. Forssmann's brilliant and courageous experiment. To guide our hand in turning this key, we had all the knowledge accumulated through the years by physiologists in their studies of animals; and to one, William F. Hamilton, I owe a more personal debt of gratitude for his constant advice and kind criticism. Basically, our difficulties were then, as they are still, those of measuring pulmonary blood flow, pressures, and volume. And, since the reliability of experimental data is no better than the reliability of the measuring techniques employed, I should like, before discussing our present understanding of the pulmonary circulation, to consider the limitations of our methods.

Measurement of Blood Flow

As D. W. Richards has pointed out (*1*), at first the measurement of pulmonary blood flow in man did not appear to pose an important problem, once catheterization of the pulmonary artery, cannulation of a peripheral artery, and spirometry supplied the data necessary to apply the principle described by Fick in 1870 (*2*). But the application of the Fick principle involves more than the simple substitution of analytic values into a ready-made equation, and the problem which had to be solved is an illustration of the caution necessary when physical principles are applied to biologic measurements (*3–5*).

The Fick principle can be used to measure flow in a physical system in which a stream of constant velocity enters a chamber of constant volume, the volume being sufficiently small so that an indicator substance continually added to the chamber is instantaneously mixed with the volume therein. Then, if the rate at which the indicator enters the chamber is measured, and if the difference in concentration of the indicator in the fluid entering and leaving the chamber is determined, flow can be calculated by dividing the volume of indicator added per unit of time by the volume of indicator gained per unit of fluid flow.

But these ideal conditions are not realized in the body, since pulmonary blood flow is pulsatile and since the rate of transfer of oxygen, the indicator substance, into the pulmonary capillaries is influenced by the cyclic character of ventilation and may be measured only at the mouth rather than at the alveolocapillary membrane. Furthermore, blood samples required for the determination of the oxygen content of the blood entering and leaving the lungs are integrated in respect to time rather than in respect to volume; in addition, they must be collected for a finite period instead of from instant to instant, as would be necessary in order to make a continuous measurement of flow.

However, as a result of extensive investigations in animal and in man, it would appear that these theoretical considerations do not introduce an error of large magnitude in the measurement of pulmonary blood flow, provided that certain criteria regarding the maintenance of a steady state of ventilation, circulation, and gas exchange are met. Thus the problems of periodic variations in flow velocity and of arteriovenous oxygen difference, and the matter of time-integrated, rather than volume-integrated, samples, do not affect the measurement of flow except under the most extreme circumstances. It was pertinent to the solution of this question to demonstrate that the volume of flow measured by the dye-dilution technique, which involves a somewhat different principle, agrees rather closely, under a wide variety of conditions, with that obtained by application of the Fick principle (*6*).

Measurement of Blood Pressures

In the early days, pressures in the right atrium and in the right ventricle were recorded (*7, 8*) through a single-lumen catheter, connected to a Hamilton manometer, a coupling which raised important technical questions. Whereas in animals it had been possible to limit the distance between the heart and the manometer to the length of a short metal needle, the use of a catheter interposed a column of fluid at least 100 centimeters long between the pressure to be measured and the pressure-measuring device. Moreover, the fluid was contained inside a tube, the stiffness of which was considerably less than that of metal; this is an important consideration in view of the fact that the fidelity of a recording system is a function of the stiffness of its parts.

It was necessary, therefore, to construct a catheter in which a compromise was made; the catheter had to be sufficiently stiff to transmit pressures accurately, but not so stiff that its introduction into the heart would be dangerous. In addition, damping had to be considered because of the low natural frequency of the system and in order to minimize the artifacts imposed by the

Dr. Cournand is professor of medicine at the College of Physicians and Surgeons, Columbia University, New York, N.Y. This article is based on the lecture he gave at the Caroline Institute, Stockholm, Sweden, on 11 Dec. 1956, when he was awarded the Nobel prize in medicine for 1956, a prize that he shared with W. Forssmann and D. W. Richards. Dr. Richards' lecture appeared in last week's issue of *Science*.

mechanical impact of the beating heart (Fig. 1). In general, the proper degree of damping is best determined empirically, since it varies with heart rate, height of pressure, and the location of the tip of the catheter. An important progress in technique was the development of a double-lumen catheter through which simultaneous pressures in two contiguous heart chambers and large vessels could be recorded.

The first two tracings of blood pressure pulses recorded simultaneously within the right ventricle and the pulmonary artery are presented here (Fig. 2). They served to illustrate a paper published in 1945 (*8*) in collaboration with Henry Lauson and Richard Bloomfield, on the use and advantages of this newly designed double-lumen catheter. For me, this tracing holds a unique place, for it is the first demonstration that the tip of a catheter was placed in the pulmonary artery of man in order to record pressure pulses. Subsequent progress in our knowledge of the dynamics of the pulmonary circulation in man (*10*) owes much to the technique of catheterization of the pulmonary artery. The part played by Lewis Dexter and his associates in this latter technical development deserves special mention (*11*).

Apart from our efforts to evolve a satisfactory catheter, considerable attention was also required for proper operation of the Hamilton manometer. Stanley Bradley, who was assigned by Homer Smith to the team studying shock at Bellevue Hospital, New York, during the years of World War II, was initially in charge of this delicate and essential function. Although the Hamilton manometer was subsequently replaced by strain gages in association with electronic recorders, it is well to recall that most of our early knowledge of pressure pulses was obtained by using this device.

During the past few years, recording machines have become increasingly complex and useful. But no matter how sensitive may be the manometer employed, the catheter system itself still remains the limiting factor in reproducing faithfully human pulse pressures, under all circumstances.

An estimation of the pressure drop across the entire pulmonary vascular system had been of particular concern to physiologists interested in the dynamics of the pulmonary circulation. Catheterization of the pulmonary artery supplied the necessary data concerning pressures at the origin of the system; but the pressure at the end of the system—that is, in the left atrium—although predictable from the diastolic pressure in the pulmonary artery of the normal subject, could not be accurately determined.

A first step in the proper direction was made when pressures were recorded from the left atrium and large pulmonary veins in human subjects under the abnormal conditions provided by interatrial septal defects (*12*); however, it was not until very recently that, by means of needles, direct measurements of the left atrial pressure in intact man have been secured. Prior to the latest development, an ingenious indirect method for making this measurement had been developed separately in 1949 by Hellems and Dexter (*13*) and by Lagerlöf and Werkö (*14*). It consists in advancing a cardiac catheter in a peripheral branch of the pulmonary artery until it is firmly wedged.

At first it was assumed that the recorded pressure was that in the first freely anastomosing segment of the pulmonary vascular bed distal to the point of wedging—that is, the capillary bed. Theoretical considerations suggest, and recent comparisons indicate, that the pulse contour and the mean pressures recorded after wedging correspond with those obtained from the left atrium, particularly in subjects with pulmonary venous congestion. This pressure, therefore, can be used with caution to derive a fairly accurate figure for the pressure drop across the entire vascular bed, particularly in cases where vascular pressures throughout the pulmonary circuit are elevated.

Measurement of Blood Volume

Since the pulmonary circulation constitutes a distensible reservoir interposed between the right and the left ventricles, measurements of pulmonary blood volume and of its variations under various physiologic conditions has attracted the interest of clinical investigators. The use

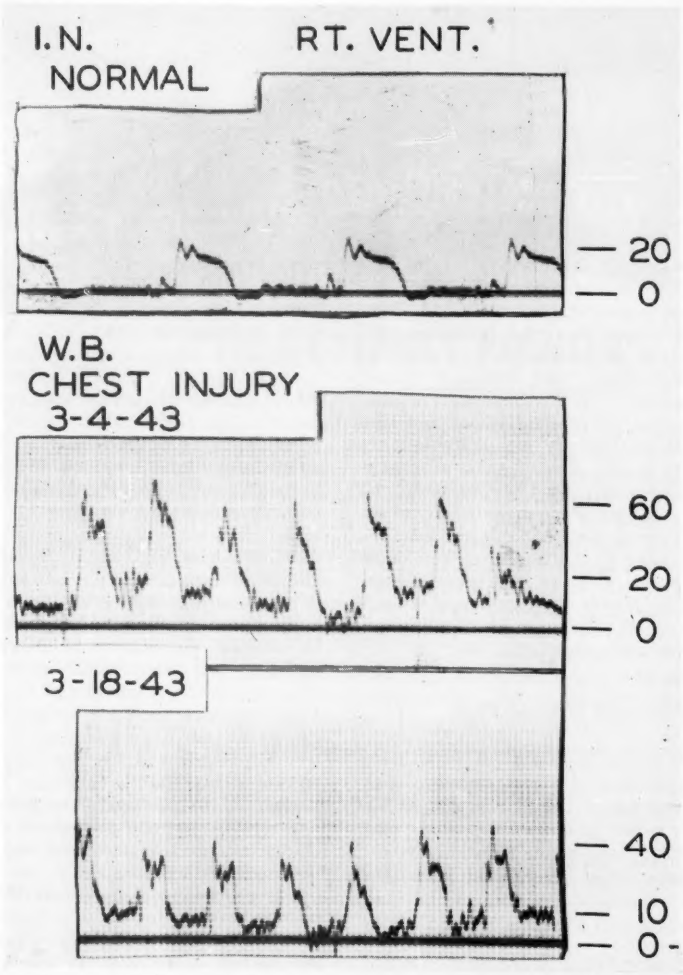

Fig. 1. The first reported pressure pulses recorded in the right ventricle of a normal man and of a patient with severe traumatic chest injury (7, chart 13). The tracings were obtained through a catheter attached to a Hamilton manometer; they are undamped. The coarse vibrations were caused by impacts on the catheter.

of the dye-dilution technique referred to in a previous section provides an indirect means of measuring this volume, according to a principle first correctly stated and then experimentally established by Hamilton and his school. However, the "central blood volume" thus measured has somewhat vague limits, and it includes the volume in the left heart and that in a large part of the arterial tree. Furthermore, the error of the technique is of the order of 15 percent of the volume measured; hence, variations of volume amounting to 150 to 200 milliliters may not be significant.

Concluding this long preamble on methodology, I now turn to the main theme of my article—the control of the pulmonary circulation in normal man.

Control of Normal Pulmonary Circulation

From the large body of previous work in animals, particularly in dogs, it was already evident at the inception of our investigation that the relationship between pressure and flow in the pulmonary circulation was quite different from that in the systemic circuit. Although the stroke output of each ventricle is approximately the same, except for temporary differences, the mean pressure in the aorta is 6 times that in the pulmonary artery. This is an expression of a much higher viscous resistance to flow in the systemic circulation—a resistance located mainly at the arterioles, the walls of which are endowed with a thick and circular layer of smooth muscles. By contrast, the walls of the small branches of the pulmonary artery have only a very thin muscular media.

Mechanical Factors

From these anatomic observations, it might be expected that the influence of the activity of this thin muscular coat on the viscous resistance to flow in the small pulmonary arteries would be a relatively weak one. Moreover, if the vasomotor tone is weak, the part played by purely mechanical factors, such as variations in blood flow and blood volumes in controlling the pressure in the pulmonary artery, becomes proportionally more important.

However, the effects of such mechanical factors are not simple. For instance, if the resistance to flow in the pulmonary vessels remained constant, then the pulmonary arterial pressure should be directly influenced by variations in flow and by variations in left atrial pressure. Since, however, the whole vascular system is distensible, the resistance in the circuit is itself dependent on variations in distending pressure. Thus, an increased flow, or an increased left atrial pressure, will by itself increase the distending pressures in the various pulmonary vessels, thus changing the geometry of the system by opening up new channels, and thereby lowering the pulmonary vascular resistances. From this it follows that the relationships between pressure and flow in the pulmonary circulation should not be expected to be rectilinear.

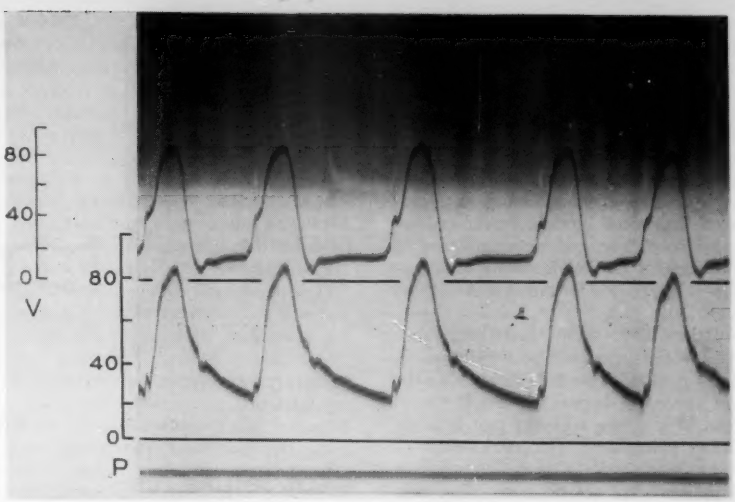

Fig. 2. The first reported pressure pulses recorded in the pulmonary artery of man (*9*). The simultaneous tracings in the pulmonary artery and the right ventricle were obtained through a double-lumen catheter attached to the Hamilton manometer in a patient with severe hypertension. The scale is in millimeters of mercury.

Indeed, it was soon apparent, from our studies, that there was not a linear relationship. For example, measurements made before and after pneumonectomy showed that the pressure in the pulmonary artery rose very little when the entire output of the right ventricle flowed through one single normal lung (*15*). Hence, the vascular resistance is strikingly dependent on the rate of flow, and the pulmonary vessels appear to be remarkably distensible within this range. Further support of this observation is provided by the relatively small rise in the pulmonary arterial pressure which is associated with a large increase in pulmonary blood flow observed during exercise in normal subjects and in patients with large left-to-right intracardiac shunts.

Beyond a certain point, however, increases in pulmonary blood flow cause greater increments in pulmonary arterial pressure, and this is presumably an indication of the shape of the curves which relate distending pressure to cross-sectional areas in the pulmonary vessels. In this respect, it is interesting to recall that Lilienthal and Riley have recently called attention to the relationship existing between the critical level at which pressure in the pulmonary artery increases significantly and the maximum oxygen diffusing capacity, a function closely related to the size of the total alveolocapillary interface (*16*).

Our experiments on the effects of the normal respiratory cycle, positive-pressure breathing, and the Valsalva maneuver (*17*) showed also the mechanical results of altering the effective, or net distending, pressure in the pulmonary vessels. In addition, they revealed that the hemodynamic situation is further complicated by differential changes in the filling pressure and thereby in the stroke output of each ventricle. These results directed our attention to the important notion of heterodynamism of both ventricles, which is particularly fruitful in the understanding of isolated ventricular failure.

Vasomotor Factors

Since remarkably wide variations in vascular resistance can normally occur in a purely passive fashion, the task of demonstrating the active part that the smooth muscles in the wall of the small vessels may play in its alterations becomes very difficult. Nevertheless, we have knowledge of two agents which appear to affect the resistance to flow in the pulmonary circulation by modifying the muscular tone of its vessels. These two agents are hypoxia and acetylcholine.

Hypoxia

Our interest in hypoxia was stimulated by the observations of von Euler and Liljestrand, who in 1946 demon-

strated a rise in the pulmonary arterial pressure of cats breathing low concentrations of oxygen (*18*). In man, we were able to confirm this phenomenon in collaboration first with Motley, Werkö, and Himmelstein (*19*). More recently, we established with Fishman, McClement, and Himmelstein that the rise of pressure in the pulmonary artery is associated with some increase in the pulmonary blood flow, and we suggested that this increase in flow is not by itself sufficient to account for the change in pressure (*4*).

Others have shown that the pulmonary wedge pressure in man and the left atrial pressure in animals and in man are not altered by hypoxia. There is, therefore, very strong evidence that hypoxia causes pulmonary vasoconstriction.

At what site has this vasoconstriction happened? We are not sure. How is it caused? We do not know. We assume that it arises directly or indirectly from the action of a low partial pressure of oxygen at some point in the body. Is it a local reflex activated at the level of the alveoli or of the pulmonary veins? Does it involve the autonomic system as a result of the stimulation of chemoreceptors in the carotid body or the aorta? Is it due to a direct action of excessively hypoxic mixed venous blood in the precapillary segment of the pulmonary vascular bed? Is there some other vasoconstricting substance liberated in the body under the influence of hypoxemia and carried by venous blood up to the lungs, or is such a substance activated in the pulmonary tissue itself under the influence of local hypoxia? Does severe hypoxemia cause a shift of blood from the systemic to the pulmonary circulation as a result of systemic vasoconstriction?

Although we are in no way near to a final solution to this problem, there are observations which give a partial answer to some of these questions as far as man is concerned. In the first place, we have not been able to demonstrate a significant increase in central blood volume under the influence of severe arterial hypoxemia. In the second place, we have studied the effect of hypoxia in a patient before and after he underwent extensive bilateral sympathectomy for Raynaud's disease. The sympathectomy, which included the stellate ganglion, the upper three thoracic ganglia on each side, and the midcervical ganglion on one side, had no influence on the rise in pulmonary arterial pressure caused by hypoxia. Thus, we reached timidly the tentative conclusion that this effect is not mediated by the sympathetic system.

Liljestrand (*20*) and von Euler (*21*) pointed out that, if the pulmonary vascular resistance were regulated on a regional basis, by a purely local action of the alveolar and blood oxygen partial pressures, this action could provide an important mechanism for maintaining the most effective ratio of ventilation to perfusion throughout the lungs. To examine this attractive hypothesis, several workers have studied the local effects on blood flow of a hypoxic gas mixture given to one lung in animals, and we have in association with Himmelstein, Fishman, and Fritts (*22*), made similar observations in man. The technique is difficult, because it includes the simultaneous use of bronchospirometry, cardiac catheterization, and arterial cannulation. By means of this technique, the flow of blood through each lung can be separately measured.

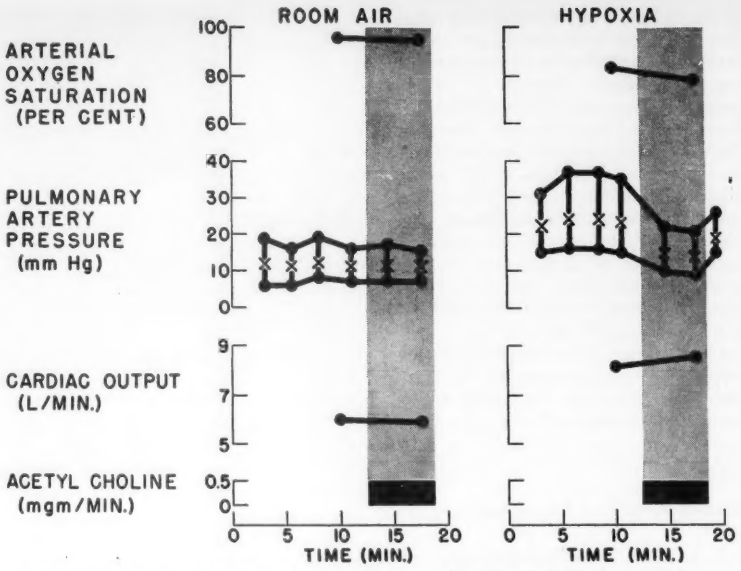

Fig. 3. Effects of acetylcholine on the pulmonary arterial pressure in a normal man. Acetylcholine was given in a continuous infusion of the main pulmonary artery at the rate of 0.5 milligram per minute (shaded areas). (Left) The subject was breathing 21 percent oxygen in nitrogen. (Right) The subject was breathing 12 percent oxygen in nitrogen.

It was found that concentrations of 8 to 10 percent oxygen in the inspired gas given to *one* lung caused no modification in the partition of flow of blood between the two lungs and no change in the pulmonary arterial pressure. Yet, giving a somewhat higher concentration of oxygen (12 percent) to both sides causes a considerable rise in pressure in the pulmonary artery. The role of a local viscerovascular reflex arising from the low oxygen tension in the alveolar gases has, therefore, been questioned. The pulmonary capillaries and venules, however, cannot be excluded as a site of origin for such a vasoconstricting reflex, since the calculated oxygen saturation of the pulmonary venous blood on the hypoxic side did not fall below the 80-percent level, which in bilateral experiments is the critical level for pulmonary hypertension.

We have, however, four observations on the effect of giving concentrations of oxygen as low as 6 percent to one lung. Here the calculated pulmonary venous oxygen saturation fell below 80 percent. In three of these studies, there was no change in the partition of flow, as compared with the control period. In one of them, there was a diminution of flow to the hypoxic lung; suggestively enough, this is the only instance in which mixed venous blood and pulmonary venous blood had an identical oxygen saturation, and where, therefore, no oxygen uptake in the hypoxic lung could be measured. Further work with even lower oxygen concentration is in progress and may well resolve the discrepancy between some of our results in man and experiments on animals in which the giving of pure nitrogen to one lung caused, indisputably, a diminution in blood flow on this side.

Acetylcholine

Here, then, the problem of the effects of hypoxia on the pulmonary vessels lies partly unsolved, and tantalizing. I turn now to the effects of acetylcholine on the pulmonary circulation. This drug has been known, since the early experiments of Sir Henry Dale, to have a strong vasodilating influence throughout the systemic arterial tree. As far as the pulmonary circulation is concerned, however, reports on the effects of this preparation in animals have been contradictory. In normal man, we have found, in collaboration with Harris, Fritts, Clauss, and

Odell (*23*), that infusion of acetylcholine into the main pulmonary artery at a rate of 0.5 milligram per minute causes a slight questionable fall in pulmonary arterial pressure. When the pulmonary arterial pressure had been previously increased by hypoxia, however, the fall in pressure due to acetylcholine was very significant (Fig. 3), although the hypoxic stimulus was maintained. This fall in pressure in the pulmonary artery was associated with no change in pulmonary wedge pressure. The cardiac output, which had increased as the result of hypoxia, remained unchanged or rose slightly further. When given in these small amounts, acetylcholine had no effect on the systemic blood pressure or pulse rate, presumably because of its rapid rate of destruction in the blood stream.

It seems fairly certain, therefore, that the action of the drug is limited to the pulmonary circulation, that this action is one of vasodilatation, and that the degree of vasodilatation is largely dependent, as one might expect, on the preexisting tone of the smooth muscles of the pulmonic vessels' wall. As in hypoxia, we do not know whether the site of action is in the precapillary, or the capillary, or the postcapillary segments of the pulmonary vascular bed. Again, as in hypoxia, we do not know through what mechanisms the drug acts.

Although they left these questions unsolved, the experiments nonetheless have to their credit three important results. They revealed that, first, blood-borne substances can act directly on the wall of some segment of the pulmonary vascular bed, second, that the effects of hypoxia in causing both an increase in blood flow and a vasoconstriction can be neatly separated, and third, that the vasoconstriction associated with hypoxia, whatever the site of its action, can be reversed.

Interplay of Factors in Disease

Although I am here mainly concerned with the relative importance of mechanical and vasomotor factors in the pulmonary circulation of normal man, it might be of interest to dwell briefly on the question of how such factors are altered by disease. In certain diseases high pressure develops in the pulmonary artery, and this is associated with a high vascular resistance and thickening of the walls of the small branches of the pulmonary artery. The hemodynamics of such a natural experiment provide an interesting contrast to those which hold good under normal conditions. The pulmonary artery pressure of these patients is found to be considerably more dependent on variation in flow and volume than it normally would be, and one may well ascribe this to a diminished distensibility of the thickened pulmonary arterial branches.

The results of experiments with sympathetic blocking agents in this group of diseases have led other workers to assign to the autonomic nervous system an important role in the control of the pulmonary circulation. I am inclined to believe that there are other alternative explanations for the striking drop of pressure in the pulmonary artery following the use of these agents rather than to claim that it is the result of blocking the nervous supply to the pulmonary vessels. For instance, translocations of even small amounts of pulmonary blood following systemic vasodilatation could have the same effect in a poorly distensible pulmonary vascular bed.

Conclusions

To summarize our present knowledge, it can be said that we have acquired some understanding of the relations between pressure and flow in the pulmonary vessels of normal man. We know also that these relations can be influenced by mechanical factors and by at least two chemical stimuli—hypoxia and acetylcholine. However, the mechanism of action of these stimuli is but poorly understood. And, when we come to fit them into an integrated concept of the control of the pulmonary circulation, we are troubled by several doubts.

The first doubt is how far such unphysiological concentrations of inspired oxygen and doses of acetylcholine throw any light on what happens under normal circumstances. The second is how to extrapolate into indefinite time the results from very short-term observations. The final doubt is whether these notions may be justifiably extended to the solution of physiopathological problems when the properties of pulmonary vessels and of the surrounding pulmonary tissue have been greatly altered.

Now, what of the future? Perhaps the only incontestable prophecy that can be made is that advances in methodology and advances in understanding will go hand in hand. Any attempt to define the limitations of our present methods of measuring pressure, flow, and volume in the pulmonary circulation points automatically to the directions in which improvements are at the moment being made. For pressure, our hope is for a reliable, pressure-sensitive head to the cardiac catheter. For flow, we look for a method of instantaneous measurement. For volume, we need some much more distinctive quantity than the central blood volume.

As progress is made, more results will pour in. Let us, then, beware of the danger of seeking security for our concepts in the accumulation of facts. As the poet has said:

> "Knowledge is proud that it has learned so much,
> Wisdom is humble that it knows no more."

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C.-E. A. Winslow, Leader in Public Health

With the death, on 8 January 1957, of Charles-Edward Amory Winslow, there came to a close a life that had been uniquely dedicated to the service of mankind. Winslow was regarded, nationally and internationally, as the elder statesman of the public health movement, a distinction he had earned through some 50 years of spirited and unremitting labor in the field of public health, including bacteriology, epidemiology, sanitary engineering, health education, industrial, mental, and social hygiene, public health nursing, housing, and the economic aspects of medical care. The record of his research and experience in these fields was set down in more than 600 books and papers, 63 of which have been published since his retirement (1945). He exerted a wide influence, also, through his editorship of the *Journal of Bacteriology* and the *American Journal of Public Health*.

For nearly 50 years Winslow's advice in matters pertaining to global public health was sought by individuals and governments, both foreign and our own. He had responsible assignments with the U.S. Public Health Service, the League of Nations, the American Red Cross, and, most recently, the World Health Organization, whose work took him on several occasions to Geneva.

Winslow was born in Boston, Massachusetts, on 4 February 1877. He held bachelor and master of science degrees from the Massachusetts Institute of Technology, an honorary master of arts degree from Yale University (1915), and a doctor of public health degree (1918) from New York University. During the 10 years from 1900 to 1910, he served on the faculty of M.I.T., teaching sanitary biology and serving as biologist-in-charge of the Sanitary Laboratory. It was in these early years that he was called on more than once to act as an expert witness in cases involving proper sewage disposal and pure water. Thus, he gave expert testimony in Chicago when that city had many long-drawn-out lawsuits concerned with the harmful effects of unpure sewage which found its way into the drainage canal, eventually to pollute the water supply in St. Louis.

Winslow subsequently taught for one term at the University of Chicago and for 4 years at the City College of New York. In 1914–15 he was director of the division of public health education, New York State Department of Health. He served concurrently, from 1910 to 1922, as curator of public health at the American Museum of Natural History, New York City. In 1915 Winslow was appointed the Anna M. R. Lauder professor of public health at the Yale University School of Medicine and, for the next 30 years, brought increasing distinction to Yale as he developed his department, one of the first in the United States, into an outstanding "laboratory" for the training of students, who flocked to him from many countries. During these years he also played a leading role in founding the Yale School of Nursing (1923) and in the creation of the New Haven Housing Authority, which he served as chairman from 1938 until his death.

To give a picture of Winslow, the man and teacher, I should like to borrow from his good friend, James Mackintosh of London, who has written: "Winslow was a commanding figure, yet he never seemed remote, in spite of his noble and somewhat aristocratic appearance. In many ways one thinks of him as the ideal teacher—eloquent, scholarly, and humane. He taught men and women of all ages and degrees of experience, at all levels, from the World Health Assembly to the smallest classroom, without ever laying down the law. . . . He pursued his subject—the health of the people—with a devotion that was passionate in its intensity. Yet he never lost touch with reality, and most of his public health ideals were severely practical. . . ." [*Lancet* **272**, 166 (19 Jan. 1957)].

It is impossible to contemplate Dr. Winslow's enormous influence in developing and shaping the field of public health without thinking also of Mrs. Winslow, the former Anne Fuller Rogers of Boston, one of his pupils, whom he married in 1907. In a tribute to William Thomson Sedgwick [*J. Bacteriol.* **6**, 225 (1921)] Winslow acknowledged his great debt to his former teacher and wrote with discernment of Mrs. Sedgwick: "Mrs. Sedgwick not only gave her husband a rare personal devotion which made his health and comfort and the success of his career a constantly controlled motive, but her artistic taste and rich temperament kept a warmth and color in his life which made it impossible for Sedgwick ever to feel those limitations which sometimes accompany a life of intellectual concentration, limitations which Charles Darwin, for example, felt so pathetically in his later years." Anyone who knew them will be struck by the aptness of this quotation to the Winslows themselves, for Mrs. Winslow was, from the first, completely absorbed in her husband's work and shared with him its problems and satisfactions to a remarkable degree.

Among the many honors that came to Winslow were the Sedgwick memorial medal of the American Public Health Association (1942), the W. Paul Anderson medal of the American Society of Heating and Ventilating Engineers (1949), the Lemuel Shattuck medal of the Massachusetts Public Health Association (1951), the Léon Bernard medal of the World Health Organization (1952), and the Mary Lasker award (1952). In 1947 a special number of the *Yale Journal of Biology and Medicine* was dedicated to him, its pages filled with contributions by his students and colleagues. And in 1952 the first Charles-Edward Amory Winslow lecture was given, under a lectureship established at Yale University through the gifts of his former students.

In the official faculty minute prepared at the time of Winslow's retirement from Yale, in 1945, there appears this sentence: "Obstacles are only stimulation for Winslow. He can use today's structure for tomorrow's scaffolding . . . ignoring minor obstacles as he climbs to the ideal others may only later understand." One might enumerate here all the areas of public health to which Winslow contributed, but I would rather repeat his own definition of "public health," since it outlines the broad aspects of the field which he tilled so widely: "Public health is the science and the art of preventing disease, prolonging life, and promoting physical and mental health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing service for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health." This represents the "ideal others may only later understand" and which they may be even longer in achieving. Toward establishing these liberal concepts—the sturdy scaffolding for tomorrow's structure—Charles Winslow gave the devoted and vigorous service of a lifetime.

JOHN F. FULTON
Yale University School of Medicine, New Haven, Connecticut

News of Science

Nuclear Test Petition

Within a few days after Linus Pauling of California Institute of Technology released his appeal for the cessation of nuclear tests, a petition that bore the signatures of some 2000 American scientists [*Science* **126**, 1190 (14 June 1957)], he was asked to testify before the Senate Internal Security Subcommittee. Subcommittee counsel Robert Morris told the press that Pauling would be questioned in order to determine whether or not "communist organizations are behind" his petition. However, the subcommittee later agreed to postpone the hearing, which had been scheduled for 18 June.

Soviet Satellite

Alexander Nesmeyanov, president of the Soviet Academy of Sciences, reports in a recent issue of *Pravda* that Soviet scientists "have created the rockets and all the instruments and equipment necessary to solve the problems of the artificial earth satellite." Nesmeyanov said also that the first satellite launched by the Soviet Union would follow an orbit not more than a few hundred kilometers above the earth's surface (a kilometer is roughly five-eighths of a mile). The *Pravda* article gave no date for the launching of the satellite; however, preparations have aimed at a target date sometime within the International Geophysical Year.

Free Drugs in New Zealand

Because of the increased cost of free medicine, the New Zealand Government has ordered that smaller quantities be supplied in each prescription. The rise in cost has been sharp: in 1941, the first full year of the government's medical program, the total amount for medicine was about $1.5 million; last year it cost about $12 million; and for the financial year just ended the bill will be at least $13.5 million. This final figure represents about $6 for every man, woman, and child. Expensive new drugs account for part of the increase; however, the prescription rate has now risen to an average of 5.3 per person.

Compton Laboratories at M.I.T.

Massachusetts Institute of Technology has dedicated the Karl Taylor Compton Laboratories, a new building for laboratories in electronics, nuclear science, and computation. There will be no restricted areas in the new laboratory building.

Graduates of M.I.T. have contributed $3,135,000 toward a $6-million program to build the laboratory and a nuclear reactor. Alfred P. Sloan, Jr., gave $1,030,000. There is a penthouse for studying cosmic rays and radio waves on the roof of the five-story structure, which also houses the new I.B.M. 704 computer that the International Business Machines Corp. installed at a cost of $2,742,000 as a contribution to research and education.

Heading the three sections of the new facility are Philip M. Morse, director of the Computation Center; Jerome B. Wiesner, director of the Research Laboratory of Electronics; and Martin Deutsch, chairman of the directing committee for the Laboratory for Nuclear Science. It will take most of the summer to move the three laboratories into their new quarters.

New York Aquarium Dedicated

The New York aquarium, which has existed only as a small collection of tropical fishes in the Bronx Zoo since the closing of the old aquarium at the Battery in 1941, has been formally dedicated in its new $1.5 million quarters on the ocean front at Coney Island. The new building is the first stage of an eventual $10-million facility that has been planned by the New York Zoological Society and the City of New York, which share equally in the construction costs. Construction of the later stages depends on private contributions, which are to be matched by the city.

The new aquarium will specialize in brilliantly colored fishes and invertebrates of the tropical coral reefs and in large and spectacular marine mammals, birds, and reptiles. Several thousand specimens of approximately 200 species were in the aquarium's tanks and outdoor pools on dedication day. The exhibits are to be changed constantly as new collections arrive from the various distant lands with which the aquarium has made collecting and exchange arrangements.

The end of one hall is devoted to a demonstration exhibit of the electric eel of South American fresh-water streams. Every half hour during the day and evening the electric eels will be stimulated to give off discharges up to 600 volts. The discharges are registered on special lights and on an oscillograph.

The main hall of the aquarium contains habitat tanks for sharks, coral-reef fishes, and invertebrates. Two of the largest tanks have been planted with artificial coral and marine vegetation. Visitors may hear what is going on in the tanks by means of "talking labels," which are heard through headphones.

Christopher W. Coates is director of the aquarium, and his staff consists of James W. Atz, associate curator; Ross F. Nigrelli, pathologist; Myron Gordon, geneticist; Carleton Ray, assistant to the director; and Aage Olsen, superintendent. John Tee-Van is general director of both the zoological park and the aquarium.

News Briefs

A neutron physics section has been established in the Atomic and Radiation Physics Division of the National Bureau of Standards. The new section will be headed by Randall S. Caswell, who has been with the bureau since 1952.

* * *

The Warner-Chilcott Laboratories has announced the integration of the company's microbiological research in its new laboratories at Morris Plains, N.J. The department of microbiology, directed by Benjamin S. Schwartz, is now composed of 21 scientists and assistants. The group that transferred from Nepera Chemical Company, Yonkers, N.Y., included Fred A. Barkley, director of the group at Yonkers.

* * *

Representatives of science, industry, business, and education met in New York on 28 May to hear Henry T. Heald, president of the Ford Foundation, speak at the 150th anniversary dinner of John Wiley and Sons, Inc.

* * *

An animal health products department has been organized at Smith, Kline and French Laboratories, Philadelphia pharmaceutical firm. Samuel F. Scheidy, assistant professor of clinical veterinary medicine at the University of Pennsylvania, has been named veterinary medical director.

* * *

The General Electric Company has dedicated its new Vallecitos Atomic Laboratory, Pleasanton, Calif.

Archeology in Southeast Asia

Archeologists working in a cave at Niah in the jungle of Sarawak, Borneo, have reached a layer of habitation dating back 10,000 years. A member of the research expedition, M. F. Tweedie, curator of Singapore's Raffles Museum, says that the finds of stone tools, pottery, matting, sea shells, and even the "leftovers" of a caveman's dinner present new evidence of the migrations of prehistoric people to what now are the multitude of islands in the Indian and Pacific Oceans.

The leader of the expedition, Tom Harrisson, curator of the Sarawak Museum in the British Crown Colony on the west coast of Borneo, has suggested that the cave should be turned into a museum for archeologists, geologists, and students of Southeast Asia. He believes the Niah Cave could turn out to be a major contribution to the understanding of the evolution of man in Asia and the islands.

Science on TV

On or about 29 Dec. of this year CBS Television will present, with the cooperation of the AAAS, a 1-hour program on the scientific advances that have taken place during 1957. In 1956 a similar program was prepared as part of a series of three telecasts that included a summary of the year's news events and a round-table report on world conditions.

The aim of the new broadcast that is being planned is to present a balanced picture of important achievements in all fields of science, basic and applied, during 1957. Preliminary work in the gathering of story material has begun. The producers of the show would like to be informed about scientific advances that could appropriately be included, especially developments that are recorded on motion picture film. Suggestions should be sent either to Raymond L. Taylor, AAAS, or to Michael Sklar, CBS Television, 485 Madison Ave., New York, N.Y.

Patent Examiners

The New York Patent Law Association reports that the Patent Office is still desperately in need of engineers and scientists to serve as patent examiners. The association reports that, while delays in the processing of patent applications in the Patent Office have been somewhat reduced during the past year, it still takes about 10 months before a new patent application is first examined, and an average of 3½ years before a patent is issued.

These delays create uncertainty about the patent status of new products and processes and tend to slow down or defer their adoption by industry and their introduction to the public. This situation should be of general concern because it can handicap the larger corporation and can be critical for the individual inventor and the small businessman whose operations revolve around patented products and processes.

Men and women holding college degrees in engineering or applied science, or a degree with a major in chemistry or physics, or with certain combined credits in these fields are eligible for appointment as patent examiners, without examination, upon application to the Commissioner of Patents in Washington, D.C.

Under the revised salary schedule the minimum starting salary is $4480 per year. Promotion to $5335 per year may be expected after 3 months' service, based solely on ability and work performance. With as little as 6 months of professional experience in engineering, chemistry, physics, or patent law, the starting salary is $5335 per year, with an expected increase to $6250 9 months later. It is usual for an examiner to be earning $8215 annually within 5 years after graduation from college, with additional opportunities for promotion up to $13,760.

The Patent Office during each of the past few years has been adding an increasing number of women to its staff of examiners, and the Patent Association stresses the fact that the Patent Office offers an unusually satisfying career for women with engineering or scientific backgrounds who wish to make full use of their training.

Euler Anniversary

Last month many of Europe's leading scientists converged upon Basel, Switzerland, to commemorate the 250th anniversary of Leonhard Euler, founder of the modern study of analytical mathematics. In the University of Basel's auditorium, Swiss scientist Andreas Speiser reviewed Euler's contributions. In addition to his work in pure analytical mathematics, Euler introduced modern abbreviations for trigonometric functions, put on paper the first complete treatises on calculus, and investigated the then obscure area of beta and gamma functions.

Although mathematics was the field closest to his heart, Euler, like his contemporary Goethe, explored a broad range of human knowledge. His studies included astronomy, hydrodynamics, optics, and music.

Despite total blindness during his last years, and undiscouraged by a fire that destroyed his home and many valuable papers, he continued to send communications to both the Prussian academy and the academy in St. Petersburg, where he had gone to live early in his life at the invitation of Catherine I. When he died in 1783, some 200 finished papers were found among his belongings.

N.Y. Central Laboratory

A $1-million research center that is equipped for work in atomic energy has been formally opened by the New York Central Railroad. This is probably the largest laboratory of its type for any railroad. The laboratory's findings should lead to more efficient operation of equipment.

ICA-Michigan Atomic Advisory Group

A consulting group designed to advise this country's International Cooperation Administration on ways to promote the peaceful uses of atomic energy throughout the world has been established at the University of Michigan. The project, operating under a 2-year contract with ICA, is being administered by the university's Memorial Phoenix Project of atomic research.

William Kerr, associate professor of electrical engineering, has been named supervisor of the group, which will be made up of six faculty members employed part-time on the contract. Later, special consultants from both on and off the campus will be called upon to assist in their particular fields.

Kerr has recently returned from Thailand, where he carried out the group's first overseas assignment: to help that government prepare a proposal for a training and research program in the atomic energy field. This proposal will be submitted to the U.S. State Department for support under the "Atoms for Peace" plan.

The following assignments will be carried out at the request of ICA's Office of Industrial Resources: (i) study the technical resources of the nations with which ICA is cooperating and recommend types of atomic energy programs technically and economically feasible for them; (ii) evaluate proposals from these nations for technical assistance and requests for equipment involving training and research; (iii) prepare estimates on the cost of facilities for the establishment of radioisotope research and training laboratories; (iv) survey the possibilities of atomic power development in the cooperating nations; (v) help ICA missions abroad disseminate information on the practical uses of radioisotopes and radiation in industry,

medicine, agriculture, and other fields; (vi) prepare training materials for ICA programs; and (vii) brief U.S. representatives or delegations planning to attend international meetings or conferences.

The new group will also take the initiative in suggesting programs or preparing materials it thinks may be of value in ICA's efforts to render technical and economic assistance to other governments. The ICA has bilateral agreements to provide information and consulting service to 56 nations.

IGY Annals

Pergamon Press has announced publication of the *Annals of the International Geophysical Year,* which will be the official journal of the IGY central committee (CSAGI). The *Annals* will describe the inception, the planning, the preparations, and the program of the IGY, and in due course the progress and some of the main results.

Harold Spencer Jones will serve as general editor with the aid of an editorial advisory board that consists of A. H. Shapley (world days), J. Van Mieghem (meteorology), V. Laursen (geomagnetism), S. Chapman (aurora and airglow), W. J. G. Beynon (ionosphere), Y. Ohman (solar activity), J. A. Simpson (cosmic rays), A. Danjon (longitude and latitude), James Wordie (glaciology), G. Laclavère (oceanography), L. V. Berkner (rockets and satellites), V. V. Beloussov (seismology), P. Lejay (gravity measurement), and M. Nicolet (nuclear radiation).

It is anticipated that from four to six volumes of the *Annals* will be published during 1957 and 1958. Subscription rates are £6 or $17 per volume. Orders should be placed with Pergamon Press at either 122 E. 55 St., New York 22, N.Y., or 4 and 5, Fitzroy Square, London, W.1, England.

Washington University

Washington University (St. Louis) has announced a gift of $200,000 from the Anheuser-Busch Charitable Trust for construction of a new laboratory for research in cellular and molecular biology. An additional grant of $150,000 from the National Institutes of Health makes possible completion of the building, which will be named the Adolphus Busch III Laboratory of Biology. Busch, who died of cancer in 1946, was president of Anheuser-Busch, Inc., from 1934 until his death. The new building is expected to be ready for occupancy late next spring.

Simultaneously, the university announced a new program of teaching and research in biology that will emphasize close collaboration among biologists, chemists, and physicists. Two new members will be added to the faculty of the department of zoology and the School of Botany, for the new program is to be established as a joint activity in those departments with the cooperation of the departments of chemistry and physics.

The program will encompass education and research in the general area involving life-processes of cells and the chemical and physical reactions which govern them. The area includes biological, chemical, and physical analyses of cellular processes such as inheritance, growth, differentiation, cell division, and metabolism as related to higher animals and plants, microorganisms, and viruses. Plans for the the new program were made by a faculty committee headed by Barry Commoner, professor of plant physiology.

Lipotropic Research

The Lipotropic Research Foundation of New York will receive applications for grants-in-aid for 1958 *until 15 Aug.,* with special attention being given to clinical studies. A request for application forms, which should include a short statement describing professional affiliations and experience, may be addressed to the administrative secretary, Dr. L. Lipton, 26 Vark St., Yonkers 1, N.Y.

Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills introduced recently follows:

HR 7465. Make the evaluation of recreational benefits, and fish and wildlife conservation, resulting from any flood control, navigation, or reclamation project an integral part of project planning. Smith (D Miss.) House Interior and Insular Affairs.

HR 7472. Amend Atomic Energy Act of 1954 to provide for establishment of an accelerated civilian atomic power program. Van Zandt (R Pa.) Joint Committee on Atomic Energy.

HR 7621. Authorize Federal assistance to the states and local communities in financing a program of atomic and disaster shelters in the Nation's schools. Edmondson (D Okla.) House Armed Services.

HR 7741. Extend for 3 years the Hospital Survey and Construction Act. Knutson (D Minn.) House Interstate and Foreign Commerce.

HR 7641. Amend section 27 of Mineral Leasing Act of 25 Feb. 1920, as amended, in order to promote the development of coal on the public domain. Thomson (R Wyo.) House Interior and Insular Affairs.

HR 7674. Amend Tariff Act of 1930 by placing beta-ray spectrometers on the free list. Gubser (R Calif.) House Ways and Means.

Scientists in the News

Eight scientists and administrative officials of the U.S. Department of Agriculture recently received Distinguished Service awards from the Secretary of Agriculture. Those honored were

ROBERT P. BEACH, assistant deputy administrator for operations of the Commodity Stabilization Service, who has made important contributions to the management phases of agricultural action programs;

JOSEPH A. BECKER, director of statistics for Foreign Agricultural Service, who has improved the statistical method employed in crop reporting;

CALLIE MAE COONS, director of human nutrition research, who is noted for her leadership in national research programs that further nutritional health;

ERIC ENGLUND, U.S. agricultural attaché in London, England, who has helped to establish international wheat and sugar agreements and to create abroad a better understanding of American agriculture;

STANLEY B. FRACKER, assistant to the administrator of Agricultural Research Service, who has been with the department for 30 years, and who is well known for his work in international agricultural scientific affairs;

RICHARD W. JACKSON, head of the fermentation section, Northern Utilization Research and Development Division, who directs a staff that has found new and economical methods for producing riboflavin, vitamin B_{12}, and other highly useful fermentation products;

ROY W. LENNARTSON, deputy administrator of the Agricultural Marketing Service, who has helped to reduce Government farm surpluses by moving them into consumption through expanded distribution at home and abroad;

RICHARD E. McARDLE, chief of the Forest Service, who has extended protection against forest fires to 20 million additional acres since he became head of the agency 5 years ago, and who has laid the groundwork for increased tree-planting under the soil bank program.

EUGENE F. MURPHY, chief of prosthetic research and development for the Veterans Administration, will leave for Denmark in July under a Fulbright award. Murphy, who is stationed in New

York, will spend 6 months as lecturer and consultant at Denmark's Society and Home for Cripples at Copenhagen. The society operates orthopedic hospitals and research and clinical facilities throughout Denmark. It also supports an international information center in prosthetics.

The Institute for Advanced Study has announced the appointment of three new professors in its School of Mathematics: ARMAND BOREL, professor of mathematics at the Federal Institute of Technology of Zürich; BENGT STRÖMGREN, director of the Yerkes, McDonald, and Royal Copenhagen Observatories and Sewell Avery distinguished service professor at the University of Chicago; and ANDRÉ WEIL, professor of mathematics at the University of Chicago.

HENRI POLAK, until recently scientific attaché for the Netherlands Embassy in Washington, D.C., and Ottawa, Canada, has been appointed European representative for Atomics International, a division of North American Aviation, Inc. He will be stationed in the North American Aviation offices that have been established in Geneva, Switzerland.

RALPH E. SNYDER has been named chief executive officer of New York Medical College, Flower-Fifth Avenue Hospital. He succeeds the president, J. A. W. HETRICK, who will retire. Hetrick, who served the institution for more than 40 years, has been president since 1942 and will continue as consultant to the board of trustees. Snyder was appointed dean in 1953 and will continue in this position.

EVERETT C. OLSON, a paleontologist, has been named chairman of the department of geology at the University of Chicago. Olson, who retains his position as associate dean of the Division of Physical Sciences, succeeds WALTER H. NEWHOUSE, chairman of the department since 1946. Newhouse resigned his administrative duties to devote full time to ore deposit research.

ROBERT L. THORNDIKE has been named head of the department of psychological foundations and services at Teachers College, Columbia University, effective in September. The department prepares students for private practice and for a wide range of psychological services in schools, colleges, and guidance centers. Thorndike joined Teachers College in 1936.

FRANCES DENSMORE, specialist in American Indian music, last month celebrated her 90th birthday at her home in Red Wing, Minn. She also observed the 50th year of her association with the Bureau of American Ethnology of the Smithsonian Institution.

In the summer of 1907 Dr. Densmore became affiliated with the Bureau as a research associate for the study of American Indian music. In the ensuing years she recorded on phonograph records some 2400 songs and prepared descriptive notes about each song. The records are now on deposit at the Library of Congress and are designated the Smithsonian-Densmore Collection of Indian song recordings. She also wrote monographs about the music and the Indian groups whose songs she recorded; these have been issued in some 20 publications of the Bureau of American Ethnology.

Dr. Densmore is the author of numerous popular articles and shorter reports which appeared in professional journals and magazines for the general reader. While recording the songs, she collected hundreds of specimens of musical instruments. Her largest collection is in the Smithsonian's National Museum.

Dr. Densmore's bulletin on Seminole music, issued by the Bureau of American Ethnology last year, proved so popular that a second printing was necessary. She has just finished correcting the page proof on a bulletin pertaining to the music of the Acoma, Isleta, Cochiti, and Zuni pueblos in the Southwest.

Editor's note: Dr. Densmore died on 5 June just after this note had gone to press.

R. PLATO SCHWARTZ, who has been on the University of Rochester Medical School faculty since 1926, will become emeritus professor of orthopedic surgery on 1 July. He will continue to direct a broad program of research in normal and abnormal walking and neuromuscular functions at the medical school's Gait Laboratory.

PHILLIP V. STONE, for 10 years an entomologist at the Wisconsin Alumni Research Foundation laboratories, has been named director of the insecticide division. He succeeds GEORGE S. KIDO, who is leaving on 1 July to accept a position as director of product development with the West Coast division of O. M. Scott and Sons, Company.

ROGER D. REID has been named director of the Biological Sciences Division of the Office of Naval Research. He will continue as head of the division's Microbiology Branch, a position he has held since 1948. Reid succeeds ORR E. REYNOLDS, who has become director of the Office of Sciences in the Office of the Secretary of Defense.

H. CORWIN HINSHAW of Stanford Medical School, a specialist in chest diseases, flew to Moscow this month to speak before the U.S.S.R.'s sixth All-Union Congress on Tuberculosis on the "Present day treatment of tuberculosis in the United States." He was the only American attending the meeting.

CHARLES C. WINDING has been named director of the School of Chemical and Metallurgical Engineering at Cornell University. He has been assistant director since 1947. Winding will succeed FRED H. RHODES, who will retire on 1 July as director and as Herbert Fisk Johnson professor of industrial engineering.

THOMAS G. PHILLIPS has been appointed emeritus professor, effective 1 July. He has been professor of agricultural and biological chemistry at the University of New Hampshire for 32 years, following 13 years in the department of agricultural chemistry at Ohio State University.

Recent Deaths

WILLIAMS B. CADWALADER, Philadelphia, Pa.; 80; retired chief in neurology of the University of Pennsylvania Hospital, former president of the American Neurological Association, and for 31 years president of the Philadelphia Zoological Society; 1 June.

FRANK L. HITCHCOCK, Los Angeles, Calif.; 82; emeritus professor of mathematics at Massachusetts Institute of Technology; 29 May.

HARRY A. KNOX, Miami, Fla.; 82; retired head automotive engineer of the Army Ordnance Department, designer of automobiles, tanks, and other vehicles and inventor of equipment for them; 2 June.

BERTHA L. ROSENTHAL, Orange, N.J.; 65; one of the first women to receive a degree in and to practice pharmacy; 1 June.

JOHN W. STINSON, Pittsburgh, Pa.; former chief of the surgical staff of Pittsburgh Hospital and regional governor of the American College of Surgeons; 28 May.

ISAAC G. SWOPE, Newton, Mass.; 54; research electrical engineer with the Lincoln Laboratory of Massachusetts Institute of Technology; 3 June.

JOSEPHINE E. TILDEN, Lake Wales, Fla.; 88; emeritus professor of botany at the University of Minnesota; 15 May.

CARL VOM BAUR, New York, N. Y.; 79; assistant engineer in the electrical section of the New York Board of Water Supply, inventor, and former engineering company executive; 28 May.

Reports

Effect of "Tranquilizing" Drugs on Amphetamine Toxicity in Aggregated Mice

In 1940, Gunn and Gurd reported that mice which were grouped with other mice were more susceptible to the excitatory effects of amphetamine and allied drugs than were single mice (*1*). In 1946, Chance reported experiments (*2*) investigating the relationship of "confinement" and "aggregation" to amphetamine toxicity. Mice that were crowded together were observed to die from much smaller doses of sympathomimetic amines than were mice in a less crowded environment. Amphetamine was particularly striking in this regard, the LD_{50} changing tenfold as a result of changing the population density. In a second paper (*3*), Chance further investigated the factors contributing to variability in amphetamine toxicity and concluded that "confinement" (that is, decrease in available space per mouse) and "aggregation" (that is, presence of other mice) were the most potent variables, overshadowing such factors as strain of mouse, sex, body weight, hydration, noise, light, and temperature.

It occurred to us that the agitated mouse in a crowded environment, suffering serious deleterious effects from the proximity of agitated mouse neighbors, resembled (albeit perhaps in a specious way) the agitated patients in a "disturbed ward" in a crowded state hospital. Specious or not, a simple experiment seemed of interest, to see whether chlorpromazine (allegedly beneficial to the agitated patient) would benefit the agitated mouse (*4*). To provide a crowded milieu, mice were placed, three in a group, in cylindrical metal canisters whose bottoms measured 13 in.^{2} in area. A screen was placed on top to keep the mice from escaping. After approximately 20 to 30 minutes in this situation, the mice were injected with racemic amphetamine sulfate (Benzedrine sulfate solution, SKF). Other mice were injected with amphetamine, but placed, one mouse to a pan, in ordinary rectangular enamel laboratory pans, measuring 104 in.^{2} in area and similarly covered with a screen. White male Swiss mice were used (obtained from Carworth Farms or Rockland Farms), each mouse usually weighing 20 to 30 g. Injections were made intraperitoneally in volumes of 0.1 ml/20 g of body weight. Experiments were arbitrarily terminated at 4 hours after amphetamine injection, for only an occasional death occurred after this time.

Our experiments confirmed Chance's observations (see Table 1, *I*): The grouped animals showed an LD_{50} approximately one-eighth that of the individual animals (*5*, *6*).

We next simultaneously investigated the effects of sodium pentobarbital, sodium phenobarbital, or chlorpromazine hydrochloride (given as Thorazine solution, SKF) (*7*) administered 20 to 30 minutes after the mice had been placed in the canisters, and followed in about 30 minutes by amphetamine. All injections were made intraperitoneally and in volumes of 0.1 ml/20 g of body weight. Pentobarbital sodium given prior to the amphetamine yielded no protection to either the grouped or individual mice (see Table 1, *I*). After doses of phenobarbital of 50 mg/kg (which produced no particular gross behavioral defect), a trend toward elevation of the amphetamine LD_{50} was seen (see Table 1, *I*) in both the grouped and the single animals. Raising the dose of phenobarbital to anesthetic levels conferred striking and significant protection against amphetamine on the grouped mice, but provided no additional protection to the individual mice. For this protection, however, the mice paid a heavy price, in that they were obviously affected (ataxic, "sleepy," and so forth) for many hours after the experiment and indeed often on the following day.

A dose of chlorpromazine (1 mg/kg) which was devoid of gross behavioral effect on the mice raised the LD_{50} of the grouped mice somewhat, without altering the LD_{50} for the individual mice. A larger dose of chlorpromazine (5 mg/kg) raised the LD_{50} of grouped animals significantly and altered the LD_{50} of individual animals only slightly (see Table 1, *I*). It should be pointed out that, even with the higher dose of chlorpromazine, animals were not rendered unconscious, and the behavior of the surviving mice seemed essentially normal at the end of the experiment. In addition, these doses of chlorpromazine are well below the LD_{50} of intraperitoneal chlorpromazine for mice (*8*), whereas in the case of phenobarbital a doubling of the 150-mg/kg dose results in deaths from the phenobarbital per se.

We have also studied promazine hydrochloride (used as Sparine solution, Wyeth (*9*) and reserpine (*10*), with the volume of injected solution and route of injection the same as previously described. Promazine seemed to be less active (by weight) than chlorpromazine in affecting spontaneous motor activity in the mice prior to amphetamine administration, and also less effective in preventing death from amphetamine (see Table 1, *II*). Because of the reported delay in onset of effect with reserpine, experiments were designed so that there was a 1- to 2-hour lag between pretreatment with reserpine and administration of amphetamine. Two doses of reserpine

Table 1. LD_{50} (± standard error) for amphetamine (mg/kg) in grouped and single mice. The drug was administered intraperitoneally.

Pretreatment	Grouped	Single
	I	
Control	14.8 ± 6.7	111.1 ± 13.1
Pentobarbital		
10 mg/kg	16.0 ± 7.9	118.1 ± 3.5
30 mg/kg	29.2 ± 7.6	117.0 ± 13.8
60 mg/kg	26.2 ± 7.6	121.5 ± 8.1
Phenobarbital		
50 mg/kg	66.9 ± 26.8	147.9 ± 6.7
150 mg/kg	112.5 ± 17.1	135.4 ± 7.5
Chlorpromazine		
1 mg/kg	42.9 ± 13.6	118.1 ± 5.7
5 mg/kg	120.8 ± 18.6	143.8 ± 7.8
	II	
Control	31.1 ± 6.6	
Chlorpromazine		
5 mg/kg	> 150	
20 mg/kg	141.7 ± 26.5	
Promazine		
10 mg/kg	55.8 ± 19.7	
20 mg/kg	68.8 ± 18.7	
	III	
Control	12.5 ± 4.3	
Chlorpromazine		
5 mg/kg	125.0 ± 14.4	
Reserpine		
1 mg/kg	108.3 ± 19.8	
5 mg/kg	96.5 ± 21.5	

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

were chosen, one which produced little if any effect per se on the mice (1 mg/kg) and one which made mice definitely "sleepy" and quiet (5 mg/kg). With both doses there was significant protection against amphetamine for grouped mice (see Table 1, *III*).

In all this work, it must be emphasized that arbitrary timing in drug administration and termination of experiments has been employed. One could conceivably miss a "protective" effect of short duration, and the superior performance of phenobarbital over pentobarbital might be explained on such a basis. On the other hand, pentobarbital deaths were seen on occasion within an hour after injection. Doses of pentobarbital larger than 60 mg/kg were not employed because of the toxicity of this barbiturate at such levels. No attempt was made to improve the performance of pentobarbital or promazine by using repeated doses of these drugs.

It thus appears that the "single" animals die with about the same frequency after administration of amphetamine whether they are "untreated" beforehand or "treated" with phenobarbital, pentobarbital, or chlorpromazine. On the other hand, phenobarbital, chlorpromazine, or reserpine (in appropriate doses) afford definite protection to grouped animals, and indeed transform the three-per-canister situation to what is, in essence (from the standpoint of mortality), a one-per-can situation.

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4. This work was supported in part by a grant from the U.S. Public Health Service, National Institutes of Health (B-865-C), and in part by a grant from Eli Lilly and Company.
5. The LD_{50} and standard error values were obtained by the Spearman-Kärber method (*6*). The usual formula for variance (q_i) which is given by Finney as $p_i\ q_i/n_i$ assumes the independence of the results on all animals at the i^{th} dose. In the experiments reported here, in which animals were grouped in canisters, it would appear likely that the death of one animal in a cannister alters the situation with regard to the effects of amphetamine on the remaining two mice. Certainly, in our experiments, the animals in a given canister did not invariably either all live or all die. Our data indicated that an assumption of no correlation within canisters was false, as was an assumption of complete correlation within canisters. Because of the size of the experiments, it was deemed unwise to get an unbiased estimate of the variance from the differences between canisters. Accordingly, rather than use either of these assumptions in estimating the variance, a conservative procedure was adopted. For doses of amphetamine in the range at which not all mice died and not all survived, the variance of the proportion surviving was estimated by $(\frac{1}{2})\ (\frac{1}{2})/k = \frac{1}{4}k$, where k is the number of canisters at the i^{th} level. A similar estimate of variance was applied to the highest dose of amphetamine at which all animals survived, and to the lowest dose of amphetamine at which all animals died. (For doses outside this range, the variance estimate was set equal to zero.) Because of the conservative nature of this variance term, the confidence limits on the LD_{50} values are probably somewhat broader than they deserve to be. A special debt of gratitude is owed to Paul Meier for his suggestions on how to deal with the statistical problems raised in these studies.
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7. Chlorpromazine was generously supplied by Smith, Kline and French Laboratories.
8. N. C. Moran and W. M. Butler, Jr. [*J. Pharmacol. Exptl. Therap.* 118, 328 (1956)] report the LD_{50} as 190 mg/kg; Paul Mattis of Smith, Kline and French Laboratories reports it to be 92 mg/kg (personal communication).
9. Promazine was generously supplied by Wyeth Laboratories.
10. Reserpine was generously supplied by Ciba Pharmaceutical Products, Inc.

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21 March 1957

Some Factors Affecting Fluorescence Maxima

The recent widespread use of recording spectrophotofluorometers, such as the Farrand and Aminco-Bowman instruments, as well as the use of manual instruments like the modified Beckman model DU (*1*), has resulted in a number of fluorescence maxima being reported in the literature. A recent paper (*2*) has brought to my attention the fact that not all investigators distinguish between "apparent" and "true" fluorescence maxima. An apparent maximum is one that is observed on a curve recorded directly by the instrument, while a true maximum is one that is observed on a curve which has been corrected for the various factors affecting it. The purpose of this report is to suggest some of the factors that affect fluorescence maxima, together with techniques for their correction, and to propose the usage of the terms *true* and *apparent* fluorescence maxima. The factors discussed should not be confused with those that affect quantum yield or relative intensity of fluorescence, which are adequately treated in a number of standard textbooks (*3*).

One factor which affects the fluorescence maximum is the degree of overlap between the long wavelength portion of the absorption spectrum and the short wavelength portion of the fluorescence spectrum. This factor is significant for a large number of compounds. If the fluorescence maximum lies to the short-wavelength end of the fluorescence spectrum (as is the case with many dye molecules and aromatic hydrocarbons), a shift of this maximum will occur toward longer wavelengths as the result of unequal absorption at each wavelength. This phenomenon is concentration-dependent and decreases with dilution.

Another factor is the relationship between the recorder-pen response (recorder time-constant) and the speed of the wavelength drive of the analyzer monochrometer. If the former is too slow or the latter is too rapid, the recorder pen will not be able to register its maximum response at each increment, particularly if the fluorescence peak is sharp. With instruments in which the wavelength dial is driven by a multiple-speed motor, the importance of this phenomenon can be easily evaluated by comparing curves recorded at different drive speeds.

A factor that is often neglected is the variation of detector sensitivity with wavelength. Most detectors do not have linear response characteristics and thus are more sensitive to light of one wavelength than of another. If one is working in the region of the spectrum where the response curve of the detector has a large slope (such as the region beyond 470 mμ, when using an R.C.A. 1P28 photomultiplier tube), a considerable difference between the true and apparent maxima can occur. (In my laboratory I have found that a difference of 15 to 20 mμ is not uncommon.) This factor is inherent in every instrument, and compensation for it can be accomplished only by correction of the recorded spectrum, at each wavelength, for the response of the detector involved. This can be ac-

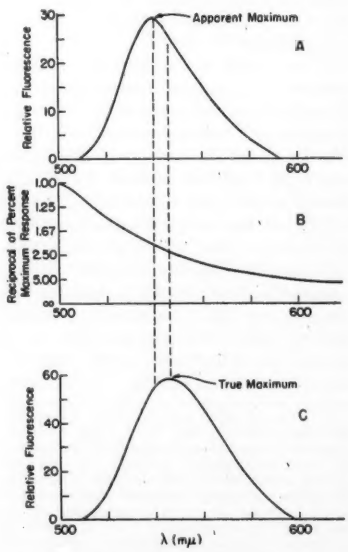

Fig. 1. Effect of detector response on recorded fluorescence curves. (*A*) Fluorescence spectrum as recorded; (*B*) detector response curve; (*C*) corrected fluorescence spectrum.

complished readily in the following manner. Figure 1*A* shows a fluorescence spectrum recorded with a detector that has the response characteristic shown in Fig. 1*B*. The true fluorescence spectrum (and hence true fluorescence maximum) is obtained by taking the product of 1*A* and 1*B* at each point and is illustrated by Fig. 1*C*. The true and apparent maxima are marked appropriately and differ by 7 mμ.

The naphthols provide an excellent illustration of this phenomenon. When a 1P28 photomultiplier tube is used, the visible fluorescence maximum of 1-naphthol, dissolved in concentrated sulfuric acid, is recorded at 528 mμ. The value obtained for the maximum, when corrected as described in the foregoing paragraph, is 544 mμ, a change of 16 mμ. Likewise, 1-naphthol dissolved in 0.2*N* sodium hydroxide shows an apparent maximum at 486 mμ, while the corrected maximum is at 500 mμ. Also, 2-naphthol dissolved in 0.2*N* sodium hydroxide and 0.1*N* sulfuric acid has apparent maxima of 424 mμ and 357 mμ, respectively, which, when corrected, give values of 429 mμ and 358 mμ. In general, response curves provided by the manufacturer of the phototube are sufficiently accurate, although for most precise results the detector may be calibrated by the National Bureau of Standards.

Scattered light from the source of excitation can also affect the fluorescence maximum and is dependent on the spectral band-pass of the analyzer monochrometer. If the fluorescence of the solution is weak, scattered light from the source can be reflected from the solution into the analyzer. If this light is of the appropriate wavelength (that is, if it is near the fluorescence maximum) it can cause a shift in the maximum recorded. The extent of this phenomenon can be readily checked by running blank solutions.

The accuracy of the wavelength calibration of the analyzer monochrometer is very important in locating the fluorescence maximum. The calibration can be checked with a low-pressure mercury arc or a hydrogen lamp (*4*).

Another factor is the slit width (spectral band-pass) of the analyzer monochrometer, for if this is too large it is conceivable that a false maximum might be obtained. This is especially true if the spectral band-pass changes with wavelength, as it does for prism instruments. The effect of this factor can be evaluated by running spectra at increasingly smaller slit widths and noting any shifts in the maximum.

A number of incidental factors can affect the fluorescence maximum. An impurity in the sample material or the solvent would have an effect if the impurity present were fluorescent. Many materials (such as benzene or alcohol) may contain traces of fluorescent impurities which could cause errors of this sort. It is often difficult to remove impurities of this type by conventional purification procedures. Fluorescence that results from the solvent can be detected by use of a blank.

A number of factors have been presented in this discussion which influence the value for the fluorescence maximum of a given compound, recorded on a specific instrument. If recorded curves have not been corrected, they are specific only for that particular instrument. However, they may be reproducible from laboratory to laboratory on an instrument of a given type, but this is not a sufficient criterion for a true maximum. It is therefore proposed that these uncorrected maxima be called *apparent* fluorescence maxima and that only those which are corrected for the factors discussed in this report be labeled *true* fluorescence maxima.

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25 March 1957

Formation of Gibbsite Aggregates in Latosols Developed on Volcanic Ash

The segregation of gibbsite on dehydration into light-colored, irregular-shaped aggregates has been observed in certain Hawaiian soils which have developed on andesitic volcanic ash occurring in the rain forest areas. These soils have been classified by Cline *et al.* (*1*) into the hydrol humic latosol soil group. These soils have been developed by the intense and rapid weathering of andesitic volcanic ash under a warm climate having a heavy rainfall ranging from 120 to 350 inches with no season which can be considered dry. Under these conditions, the primary silicate minerals of the volcanic ash have decomposed, and many products of weathering have been leached from the soil. The free and rapid percolation of water has provided conditions favoring the removal of the released soluble silica. The desilication has been accelerated by the organic acids, which are provided by the decomposition of the mixed fern vegetation.

Table 1. Chemical composition of the light-colored aggregates of gibbsite formed on dehydration of soils of the hydrol humic latosol group. All figures are percentages.

Location	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	H_2O
Onomea	0.89	61.88	0.88	2.76	31.88
Kaiwiki	0.72	63.03	1.20	3.02	33.09
Hilo Sugar Co.	0.62	62.22	2.28	1.28	33.40
Hakalau	0.90	61.60	2.08	4.52	31.52
Pepeekeo	0.69	62.81	0.88	2.22	32.60
Hilo Forest Reserve	0.58	63.30	0.90	1.22	32.89
Average	0.72	62.46	1.37	2.50	32.55

The greatest development of the soils of the hydrol humic latosol group occurs on the beds of andesitic ash found on the slopes of Mauna Kea on the island of Hawaii. These soils are smeary, gelatinous clays which, upon dehydration, form a mixture of light- and dark-colored aggregates. The aggregates will not rehydrate to form the clay but instead become very water-stable aggregates. The volume weight of these soils is extremely low, ranging from 0.1 to 0.7 and averaging approximately 0.5. The soils often contain from 60 to 65 percent water; however, they have formed a very stable land surface.

The mineral and chemical composition of typical soils of the hydrol humic latosol group has been reported by Tamura *et al.* (*2*). The major mineral constituents which were identified and estimated in this report (*3*) are as follows: gibbsite, 25 to 33 percent; allophane, 13 to 26 percent; goethite, 10 to 34 percent; magnetite, 6 to 19 percent; and anatase, mica, silica, and quartz in minor amounts.

On drying, these soils lose volume. In the process of drying, light reddish-brown mottles are formed by congealing gel-like structures which separate from the darker-colored matrix. On further drying, the light-colored areas form solid aggregates which feel gritty in the dehydrating system. Finally, on complete dehydration, a mixture of light- and dark-colored aggregates is formed. The light-colored aggregates have been identified as gibbsite, the trihydrate of aluminum oxide, by chemical and differential thermal analysis. Tamura (*4*) has also confirmed this identification by x-ray diffraction procedures. The chemical composition of the six separations of light-colored aggregates is given in Table 1. The average alumina content of the aggregates is 62.46 percent, and the average water loss between 110° and 400°C is 32.55 percent. Only minor quantities of silica, iron oxide, and titanium oxide were found in these aggregates.

The dark-colored aggregates have a high content of silica, more than 20 percent, and also iron oxide, 30 to 40 percent. These aggregates are strongly magnetic, thus providing a method of separation from the light-colored aggregates.

The process by which the gibbsite aggregates are formed has not been established. The indications strongly suggest that the alumina has been precipitated from the percolating waters in the pores, cavities, and drainage channels occurring in the soil. The best evidence of this is the fibrous structures often found in these aggregates. The segregation of gibbsite into discrete aggregates may provide a means for its commercial development as a source of alumina.

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25 February 1957

Preparation and Properties of Antihuman Properdin Rabbit Serum

A specific antiserum for properdin is desirable (i) as a tool for characterizing properdin and its interactions and (ii) for the possible development of quantitative immunochemical procedures for the measurement of properdin. In addition, studies on the antigenicity of properdin are necessary to determine whether heterologous properdins can be employed for *in vivo* experiments.

Partially purified properdin (1000 units/mg of protein nitrogen) was prepared from human serum as is described elsewhere (*1*) and was measured by the zymosan assay (*1*).

Albino rabbits were given six to ten 1000-unit injections of human properdin intravenously over a period of 10 to 14 days. One to 3 months later they were given a single injection of 1000 units and were bled 2 to 4 days following this single injection. About 20 percent of the rabbits produced satisfactory antiserums.

Serums were separated in the usual manner and were stored at −70°C. Aliquots of anti-HP were heated at 56°C for 1 hour (anti-HPΔ). Other aliquots of anti-HPΔ were incubated with 1 to 2 vol of human serum deficient in properdin (RP) for 1 hour at 37°C and then at 1°C overnight. The mixtures were centrifuged at 4000 rev/min for 1 hour at 1°C, and the supernatants [anti-HP(A)] were stored at −70°C until used. Normal rabbit serum, antihuman gamma globulin rabbit serum and antihuman serum rabbit serum (Coombs) were treated in a similar fashion.

For the measurement of antiproperdin activity, 0.2 ml of varying dilutions of antiserums were added to known amounts of either purified properdin or human serum of known properdin content. The mixtures were incubated at 37°C for 1 hour and, in certain experiments, at 1°C overnight. The samples were then centrifuged at 4000 rev/min for 1 hour, and the supernatants were titered for properdin and components of complement. Adequate controls, which included normal rabbit serum, Coombs serum, and isotonic sodium chloride or buffer, were always run simultaneously. The antibody titers are expressed as the number of units of properdin inactivated or neutralized by 1 ml of antiserum. Thus, if 0.2 ml of a 1/5 dilution of antiserum inactivated 5 units of properdin, the sample was considered to contain antibodies capable of neutralizing 125 units of properdin per milliliter of serum.

The results of numerous experiments on the serological properties of anti-HP are summarized in Table 1. It will be seen that the antibody to properdin was stable to heating at 56°C for 1 hour. Anti-HP and anti-HPΔ also formed precipitates with fresh human serum and inactivated complement. However, adsorption of anti-HPΔ with RP (human serum deficient in properdin) removed all demonstrable complement-fixing and precipitating antibodies and provided a serum [anti-HP(A)] which appears by present criteria to inactivate properdin specifically. Preliminary experiments indicate that purified properdins from other species are also inactivated to varying degrees by anti-HP(A). Normal rabbit serum and several Coombs serums did not inactivate properdin.

Table 1 shows that treatment of anti-HP(A) with purified properdin or properdin-zymosan complexes (PZ) completely removes the antibody to properdin. Complexes formed from zymosan and heated serum, as well as zymosan alone, were ineffective. The specificity of properdin for the removal of antibody from anti-HP(A) and the lack of dependence on temperature for this removal further substantiate the concept that the substance in immune serum which inactivates properdin is a specific antibody to properdin.

The results presented so far were obtained by measuring properdin in the zymosan assay. It is known that the properdin system inactivates certain viruses (*2*) and phages (*3*), kills certain bacteria (*4*) and protozoans (*5*), and hemolyzes abnormal red cells (*6*). It seemed necessary to determine whether the anti-HP(A) employed in this study would also inactivate properdin in these systems. Accordingly, samples of anti-HP(A) were sent to the investigators mentioned in Table 2 for evaluation of the activities of this antiserum. Their results are summarized in Table 2, which shows that these investigators employing different methods of assay for the measurement of properdin arrived at similar values for the antiproperdin potency of the anti-HP(A).

The foregoing experiments (*7*) show that immunization of rabbits with puri-

Table 1. The inactivation of human properdin by antihuman properdin rabbit serum.

Sample	Units of properdin inactivated per milliliter of serum	Complement-fixation with human serum	Precipitation with human serum
Untreated antiproperdin rabbit serum (anti-HP)	200–300	++++	++++
Anti-HP heated at 56°C for 1 hour (anti-HPΔ)	200–300	++++	++++
Anti-HPΔ adsorbed with RP [anti-Hp(A)]*	80–120	−	−
Anti-HP(A) adsorbed with properdin†	0	−	−
Anti-HP(A) adsorbed with properdin-zymosan complex‡	0	−	−
Anti-HP(A) adsorbed with zymosan	80–120	−	−
Antihuman γ-globulin or antihuman serum rabbit serums§	0	± to +++	± to ++++
Normal rabbit serum	0	−	−

* 1.5 ml of RP (human serum deficient in properdin) per milliliter of anti-HPΔ.
† 100 units of purified human properdin per milliliter of anti-HP(A).
‡ Complex was formed from 20 mg of zymosan and 10 ml of fresh human serum. Complexes formed from heated serum were ineffective in adsorbing antiproperdin.
§ Different Coombs serums varied in their ability to fix complement or to form immune precipitates.

Table 2. Comparison of the activities of antihuman properdin rabbit serum in different systems that require properdin.

Method	Investigators	Units of properdin inactivated by 1 ml of anti-HP(A)
Inactivation of C'3 in zymosan assay (*1*)	This laboratory	80–120
Inactivation of C'3 in zymosan assay (*9*)	H. Isliker	60– 80
Hemolysis of PNH erythrocytes (*6*)	C. F. Hinz, Jr.	80–120
Bactericidal activity against *Sh. dysenteriae* (*4*)	R. J. Wedgwood	100–200
Inactivation of coliphage, T2 (*3*)	H. Van Vunakis, J. L. Barlow, and L. Levine	100–200

fied human properdin, under appropriate conditions, results in the appearance in their serum of antibodies which inactivate properdin. This suggests that the use of heterologous properdin in experimental animals or patients may be undesirable because of its antigenicity.

Antihuman properdin rabbit serum is stable to heating at 56°C for 1 hour; it inactivates properdin almost instantaneously at either 37°C or 1°C; and its antiproperdin activity is removed by adsorption with purified properdin or properdin-zymosan complexes (PZ) but not by human serum free of properdin (RP) or by zymosan. The antiserum after adsorption with RP appears to inactivate properdin specifically. Such adsorbed serums do not inactivate complement or its components, nor do they react visibly when added to untreated human serum or purified properdin. Either the antibody content of the serums is too low to give a visible precipitate with properdin or antiproperdin is a nonprecipitating antibody. Isliker (*8*) was unable to detect the formation of any bands in the Ouchterlony agar diffusion technique with mixtures of anti-HP(A) and human serum. However, work being conducted with E. R. Arquilla shows that human red cells which have been coupled to purified properdin by diazotization are agglutinated by antiproperdin rabbit serum but not by normal rabbit serum or by antihuman gamma globulin or antihuman serum rabbit serums. Hemagglutination is inhibited by properdin and serum reagents containing properdin. This suggests that hemagglutination inhibition reactions may eventually be employed for the detection or quantitative measurement of properdin.

It is encouraging that five different laboratories employing four different means of measuring properdin were in agreement on the antiproperdin activity of the serum [anti-HP(A)] furnished them (Table 2). Thus, antiproperdin antibodies inhibited the bactericidal, virus-inactivating, hemolytic, and C'3 inactivating properties of normal serum or human properdin in a similar manner.

The availability of antiproperdin serums should help in the characterization and measurement of properdin and in the clarification of the nature of the interactions of the properdin system with various infectious agents, red cells, and polysaccharides.

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15 May 1957

Graded Collodion Membranes for Separation of Small Molecules

In the course of doing work on a problem in protein chemistry, it became apparent to us that it would be useful to have membranes that could make separations between molecules that are smaller in molecular weight than 30,000. The preparation of membranes of graded porosity in the range of pore sizes above those we were interested in had already been worked out in detail (*1*). However, there has been no detailed study of the preparation of membranes with graded porosity in the lower range of pore sizes.

As early as 1915, Brown (*2*) showed that dried collodion membranes swelled when they were placed in solutions of ethanol and water: the higher the concentration of ethanol, the greater the degree of swelling, and, hence, the greater the porosity of the membrane. However, this idea has never been followed up to any extent, and very little use has been made of it. The purpose of the present work (*3*) has been to make a detailed study of the method of Brown in an effort to make the desired graded collodion membranes under carefully controlled conditions. The procedure that we have found suitable for the reproducible preparation of such membranes is as follows.

Collodion membranes are cast according to the procedure described by Gregor and Sollner (*4*). Collodion solution is poured in succession over six rotating test tubes that have been specially prepared for this purpose (*5*). The tubes each have a 2-mm hole in the bottom which has been sealed by allowing a drop of caramelized sugar to harden in the hole.

Three minutes after the first layer is placed on the tubes, a second layer is put on in exactly the same way as the first. The resulting two-layer films are allowed to dry on the rotating tubes for at least 30 minutes. The tubes can then be removed from the casting apparatus and allowed to stand at room temperature for about 6 hours or until they are completely free of solvent. They can stand longer at this point; however, it is best to remove the membranes from the tubes within 1 day after casting.

To remove the membranes from the tubes, the tubes are placed in water at room temperature for 2 hours. This allows the caramelized sugar in the hole at the bottom of the tubes to dissolve completely and also allows the membrane to become saturated with water. If flat membranes are desired, they may be cut off the tubes with a sharp knife. If bag-shaped membranes are desired, they can sometimes be obtained by slipping the membranes off the tubes after the soaking in water. When the membranes do not loosen and come off after this treatment, the tubes with the membranes still on them are placed in 70 percent ethanol for 1 to 2 hours. They are then put back in water and, after 2 or 3 minutes, the membranes may be slipped off the tubes. After the membranes have been removed from the tubes, they are allowed to dry again at room temperature. Drying is continued until no water droplets are visible.

The next step, which results in the grading of the porosity, is to place the dried films in varying concentrations of ethanol. Our ethanol solutions have been prepared as follows: An 85-percent

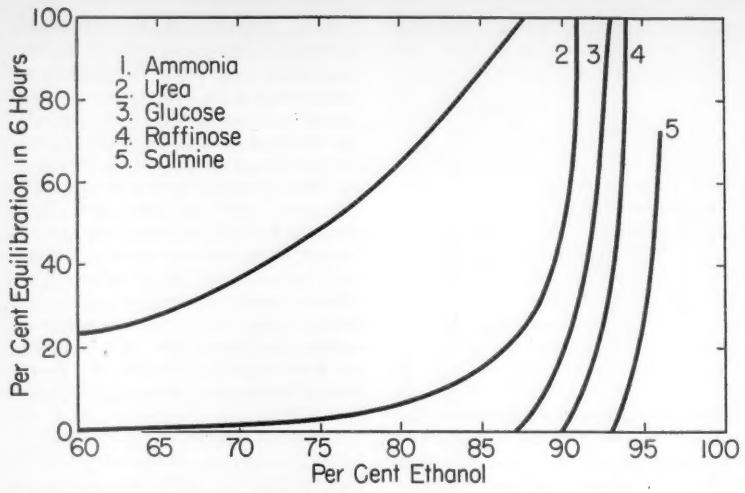

Fig. 1. Permeation of solutes through collodion membranes previously swelled in ethanol-water solutions.

ethanol solution is made by mixing 85 ml of absolute ethanol (water-free) with 15 ml of water; a 95-percent ethanol solution consists of 95 ml of ethanol and 5 ml of water, and so forth. The membranes are kept in the ethanol solutions for 3 hours, preliminary experiments showing that the degree of swelling changes very little after this time. They are then placed in water until they are used.

The determination of the degree of porosity of the membranes was carried out, for the most part, by measuring the rate at which solutes of various sizes diffused through the membranes. In this way, we would know directly whether or not a certain degree of swelling was suitable for a particular separation.

A solution containing the solute to be tested was placed inside a bag-shaped membrane (12 by 100 mm), and water was placed outside. The membrane with solution was placed in a 25- by 100-mm test tube containing 20 ml of water. It was then placed in a thermostat at 25.1°C, and the concentration of the solute which appeared in the outside solution was determined after 6 hours. From the initial volumes and concentrations in the two compartments, the equilibrium concentration was known. From the concentration in the outside solution at 6 hours, the percentage of the equilibrium value was calculated. A summary of results we have obtained using this procedure is shown in Fig. 1.

The curves in Fig. 1 are quite reproducible if such variables as membrane thickness and swelling conditions are controlled carefully. For example, in a given series, ten 90-membranes tested with urea gave an average value of 63.4 ± 2.5 percent equilibration. The variation from series to series, however, is not quite as good. When a particular point on one of the curves is checked with new collodion solutions, new reagents, and so forth, the variation may be as much as 15 to 20 percent from the original value.

For membranes swelled in 94-percent ethanol and higher concentrations, we have used ultrafiltration as a method of characterization. Ultrafiltration of solutions being tested was carried out with the 12- by 100-mm membranes according to the technique of Clegg (*6*). The membranes were placed in nylon bags which were then suspended in 15-ml centrifuge tubes. When centrifugation was carried out at 1000 to 1500 rev/min, liquid collected at the bottom of the tube, the rate depending on the porosity of the membrane. The resulting liquid was then tested for solute.

Using this procedure, we found that the 94-percent membranes just held back lysozyme, the 96-percent membranes just held back egg albumin, and the 97-percent membranes just held back serum albumin. This is about the upper limit in porosity that can be obtained with this method. Membranes swelled in 98-percent ethanol for 30 minutes are very weak, and 99-percent ethanol dissolves the film completely in a very short time.

To test these membranes further, separations of two different substances by dialysis have been attempted by placing a solution of the two substances inside a given membrane and water outside. With a membrane swelled in 90-percent ethanol and urea and sucrose as the solutes, it was found that in 36 hours the urea concentration was reduced to 10 percent of its original value, while the sucrose concentration was unchanged. With a membrane swelled in 87.5-percent ethanol and urea and glucose or urea and the tripeptide, glycylglycylglycine as the solutes, it was found that when the urea concentration was reduced to 5 percent of its original value, there was a 10 to 15 percent loss of the larger solute in the dialyzate. In these instances when the ratio of the molecular weights of two solutes is as low as 3/1, a complete separation is not obtained. Nevertheless, such separations could still be practical, especially if fractional dialysis were employed. Craig and King (*7*) have recently shown that fractional dialysis with cellophane membranes can be quite useful in estimating the size and homogeneity of unknown solutes. The availability of a series of graded membranes covering the smaller solute range should make this technique even more useful.

We have made practical use of these membranes in the separation of salts from low-molecular-weight proteins and polypeptides by means of electrodialysis. In addition, we have been able to make studies on the equilibrium dialysis of solutes which diffuse through the conventional dialyzing membranes (*8*).

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22 March 1957

Liver Catalase and Tumor Inhibition by Urinary Extracts

The influence of tumor growth on the liver catalase content has been noted by many workers; in particular, Adams (*1*) has reported on the changes in this enzyme that follow the injection into mice of homogenized sarcoma-37 tissue.

Within about 4 days, the liver catalase was found to diminish rapidly—a fall which was not characteristic of tumor growth (*2*)—and then to rise almost to the original normal value. Later a somewhat more gradual reduction was observed, coincident with the growth of the established tumors, the effect being more marked in male animals. In view of the afore-mentioned findings, tumor inhibitory extracts of urinary concentrates were examined also for their effect on the depression of liver catalase produced by the growth of sarcoma-37 tumors in inbred male albino mice.

For the preparation of the extracts, acidified tenfold concentrates of pooled human male urine were treated with absolute ethanol in amounts equal to one-half of their volumes; the resultant precipitates were discarded, and the filtrates were concentrated seven to eight times under reduced pressure; then further equal volumes of ethanol were added. Again, the precipitates that resulted from the incorporation of the ethanol were filtered off and discarded; the evaporation of the solvents from the filtrates, under reduced pressure, was continued in these instances to approximately a 15-fold concentration. From these residues it was difficult to distill any more water.

The additions to the viscous brown residues of absolute ethanol (of half the volumes previously employed for precipitation) resulted in solutions that contained most of the urinary solids; these were repeatedly extracted with ether. Evaporation of the ether and ethanol from the bulked extracts provided very thick oils, which constituted one part of the extracts under investigation.

Further tumor inhibitory material was obtained, from the small, aqueous residues that remained from the ether extractions, by a third treatment with equal volumes of absolute ethanol. The resultant precipitates were again discarded, and the filtrates were evaporated to dryness, under reduced pressure, to yield the other parts of the combined urinary fractions that were employed.

The total dark brown, gummy material thus extracted was brought into aqueous solution by the addition of excess 5*N* sodium hydroxide, at room temperature. The dialysis of these solutions was accomplished in Visking synthetic cellulose casings against running tap water for 3 hours, during which time much water entered the casings. The products remaining within were then concentrated, under reduced pressure, to volumes suitable for their homogeneous incorporation into sufficient rat cake to provide a daily ration of 2.5 g per mouse (*3*); this amount was also given, unadulterated, to the control animals. In each experiment, the average daily mouse dose of these urinary fractions corresponded to the amount excreted in 400 ml of freshly voided, pooled male urines.

For the observation of the variations in the liver catalase levels, groups of from 4 to 6 control mice and from 5 to 7 experimental mice (all 6 weeks old at the beginning of the study) were sacrificed at intervals of 2 to 3 days (excluding weekends), commencing from a date 6 days after implantation of small fragments of actively growing sarcoma-37 tissue. Enzyme estimations on the liver homogenates were carried out in duplicate by the titration method of Adams (*1*), but 0.042*M* hydrogen peroxide in phosphate buffer *p*H 6.8 was used, in order that the fraction of the substrate destroyed should not be unduly high. Units of catalase action were calculated, as by Adams, in relation to liver nitrogen. Tumor areas were derived from the product of two diameters of the tumors

Table 1. Liver catalase levels in inbred male albino mice bearing growing sarcoma-37 transplants, during oral treatment with urinary extracts. (Tumor areas are calculated from the product of two diameters of the tumor, taken at right angles. Liver catalase was measured by the method of Adams, *1*.)

Days after tumor inoculation	Controls		Treated mice	
	Avg. tumor area (mm^2)	Liver catalase (units)	Avg. tumor area (mm^2)	Liver catalase (units)
		Experiment 1		
0	0	106	0	106
6– 7	20	89	20	75
8– 9	41			82
10–11	101	58	47	
12–13			90	82
14–15	220	55		
		Experiment 2		
0	0	101	0	101
6– 7	24	89	15	102
8– 9	43	85	27	103
10–11	66	72	40	
12–13	100			
14–15	126	60	80	85
16–17	148	44	106	
18				55
		Experiment 3		
0	0	95	0	95
6– 7	11	90	8	106
8– 9	32	72	22	116
10–11	60	65	38	105
12–13	100		65	88
14–15	130	43	65	70
16–17	155	41		77
		Experiment 4		
0	0	95	0	95
6– 7	11	90	5	83
8– 9	32	72	14	124
10–11	60	65	18	
12–13	100		25	78
14–15	130	43	40	85
16–17	155	41	56	96
		Experiment 5		
0	0	99	0	99
6– 7	17	94	13	92
8– 9	38	75	31	103
10–11	64	81	50	90
12–13	109		76	
14–15	150	43	70	77
16–17	201	29	83	57
		Experiment 6		
0	0	99	0	99
6– 7	17	94	17	101
8– 9	38	75	26	108
10–11	64	81	51	
12–13	109		85	85
14–15	150	43	88	82
16–17	201	29	100	54

at right angles, measured with calipers.

From Table 1 it is apparent that the subcutaneous implantation of sarcoma-37 fragments into inbred male albino mice has resulted in a pronounced effect on their average liver catalase levels. From the sixth day after tumor inoculation, the enzyme content in the controls was progressively reduced to a marked extent, while the growth of the established tumors was steady and rapid. However, this depression of liver catalase was prevented, in large measure, by the oral administration of the urinary fractions, and, at the same time, the growth of the sarcoma-37 transplants was appreciably inhibited.

Of the smaller acidic molecules extracted from the urinary concentrates, many would have been able to pass through the dialysis membranes as their sodium salts, while proteins and similar large molecules would either have been precipitated by the additions of ethanol or else adsorbed upon the resultant precipitates. It might therefore be expected that the range of molecular weights contained in the extracts employed for these initial investigations would be restricted to comparatively narrow limits, although they were undoubtedly chemically diverse in nature.

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1 April 1957

Water Taste in Phormia

The chemosensory hairs on the labellum of the blowfly *Phormia regina* have been studied extensively. Behavior studies indicate that there are at least two modalities of sensation: acceptable and unacceptable (*1*). Anatomical investigations have shown that there are two neurons associated with the receptor site at the tip of the hair (*2*). Electrophysiological techniques have demonstrated that the two neurons are differentially affected by salt and salt-sugar mixtures in water solution (*3*). Efforts to record the electric response to distilled water and to pure sugar solutions have been unsuccessful. These responses must be found in order to work out a complete theory of chemoreception in *Phormia*.

The present method of recording nerve discharges from single hairs makes it possible to study the response to distilled water and to many types of sugar and/or salt solutions (*4*). Basically, this method is a refinement of the earlier techniques, in which a 50-μ glass capillary, filled with the stimulating liquid, is brought into contact with the tip of the hair. A silver-silver chloride wire, in contact with the stimulating liquid and one input lead of the preamplifier, allows the capillary to be used as the recording electrode. The indifferent electrode is an uninsulated silver-silver chloride wire, which is inserted into the proximal end of the detached labellum of the fly.

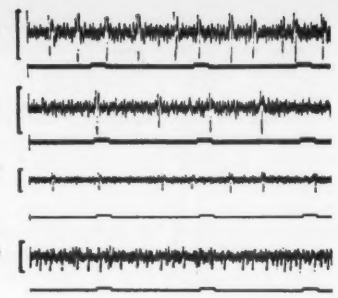

Fig. 1. (*A*, *B*) Response of a long hair to distilled water. (*C*) Response of a long hair to 0.1*M* *d*-fructose. This hair had no response to distilled water; (*D*) Response of a long hair to 0.1*M* *d*-fructose. This hair had a response to distilled water similar to *A*. In all records the time marks are 0.2 sec, and the voltage calibrations are 200 μv.

Because of the very high resistance (about 10^{10} ohms) of the recording electrode when it is filled with distilled water, a high impedance, negative capacitance preamplifier, designed by MacNichol and Wagner, was used (*5*). The output of this was fed into a conventional direct-current amplifier and oscilloscope for observation and photography. The response was occasionally recorded on magnetic tape, which was later played back and displayed on the oscilloscope for photography.

From behavior studies it is known that distilled water will produce a positive feeding reaction in a thirsty fly. The electric response to distilled-water stimulation consists of large and small impulses intermixed, with a high initial rate of discharge, as is shown in Fig. 1*A*. Adaptation to a lower frequency is rapid and at a different rate for each of the two neurons, as can be seen from a comparison of *A* and *B* in Fig. 1. These are portions of the same record, in which 30 seconds have elapsed between *A* and *B*. The final frequency of the small impulse may become zero in many cases. This response is similar to that obtained from a dilute salt-sugar solution. The character of the response is similar among hairs of the same type on the same labellum but varies from fly to fly. These variations seem to be dependent on the age and nutritional state of the fly. Experiments to explore this relationship are now in progress. Water-satiated flies may have little or no response to water—a single impulse every 5 or 10 seconds.

The response to a pure sugar solution may show a discharge from only one neuron or from two neurons, as is shown in Fig. 1*C* and *D*. In cases where only one neuron discharges, there is little or no response to stimulation by distilled water alone. A two-neuron response to pure sugar solution is usually found in a hair where there is a vigorous water response. This suggests that the sugar stimulates only one neuron and that the discharge of the second neuron is from the stimulation by water. In this way, the response to any solution can be analyzed into two parts: (i) the response to water and (ii) the response to the solute. Of course, if the hair has little or no response to distilled water, then its response to a solution will be almost entirely attributable to the solute. The question of whether or not the water stimulation sums linearly with that of the solute is being investigated in detail for different types of solutes.

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26 April 1957

Equilibria as Origin of Differences in Spectra of Chlorophyll in Different Solvents

In the studies of the absorption spectra of solutions of chlorophylls from room temperature to the temperature of liquid nitrogen (*1*), the existence of several molecular species in equilibria became evident. These species were later (*2*) identified as solvates. It was surmised that the chief differences in the well-known spectra of a given chlorophyll from one solvent to another at room tem-

perature arose from different relative amounts of solvates.

This discussion is limited to chlorophyll *b*; chlorophyll *a* and some chlorophyll derivatives had unmistakably the same behavior. In Fig. 1 are given the absorption spectra of chlorophyll *b* in ethyl ether and in methanol at room temperature (300°K) according to Harris and Zscheile (*3*). The inset at the upper right corner of Fig. 1 shows the change in its Soret band at about 4500 A with temperature at a greater dispersion of wavelengths. The solvent of chlorophyll *b* at room temperature (300°K) was 20 percent propyl ether and 80 percent hexane. At the three lower temperatures, it consisted of 20 percent propyl ether, 40 percent propane, and 40 percent propene. As may be seen, the spectrum of the chlorophyll in ether at room temperature is very similar to that in the ether at 75°K, except for a shift toward longer wavelengths. (It has been repeatedly shown that the spectra of chlorophyll in ethyl ether and in propyl ether are indistinguishable, and likewise no change is produced by the substitution of hexane for propane and propene, which are gases at normal temperature and pressure.) The maxima shown at 180°K represent the two solvates, probably the monoetherate and the dietherate. The latter has its maximum at a longer wavelength than does the former. Notice that, at the extremes of temperature, the shape of the bands of these two solvates is roughly the same except for greater detail, chiefly a shoulder toward the long wavelength at the lowest temperature. It was the resemblance of the rather symmetrical shape of the composite spectrum of the two coexisting solvates in ether at 180°K to the shape of the spectrum of chlorophyll in methanol at room temperature which suggested that, in this solvent also, two solvates were present in appreciable concentrations. The presence of two maxima in the composite band at the lower temperature and their absence at the higher would be connected with the improved resolution usually achieved at lower temperatures.

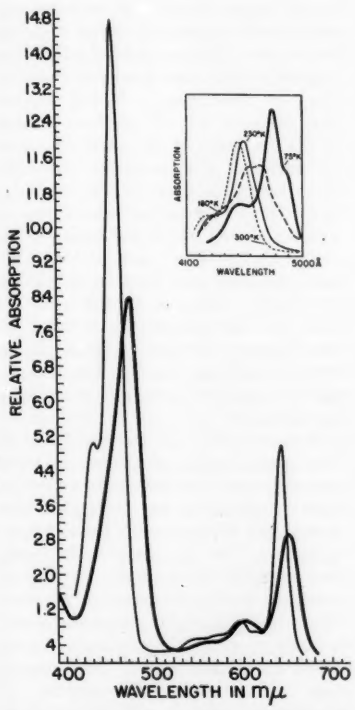

Fig. 1. Absorption spectra of chlorophyll *b* at room temperature. The thin-lined curve with maxima at shorter wavelengths represents a solution of chlorophyll in ethyl ether; the thick-lined curve gives the spectrum when the solvent is methanol. (Inset) Changes with temperature of the absorption spectra of chlorophyll *b* in solution. At 300°K, the solvent was 20 percent propyl ether and 80 percent hexane. At the three lower temperatures, it was 20 percent propyl ether, 40 percent propane, and 40 percent propene.

This interpretation is amply confirmed by the following observations. The left of the lower pairs of curves of Fig. 2 gives the Soret band of chlorophyll *b* in pure propanol at room temperature. When the alcohol is diluted to 9 percent by volume with hydrocarbons, the spectrum becomes that on the right side of the lower pair of Fig. 2. The characteristic shoulder about 150 A toward short wavelengths has appeared, and the main peak is now at shorter wavelengths. This shoulder with its maximum has proved to be a criterion (*2*) that, predominantly, a single solvate of the chlorophyll is present. In Fig. 1 it is an etherate; here it is presumably a monoalcoholate. The left of the upper pair of curves of Fig. 2 shows the spectrum of chlorophyll *b* in a solution 14 percent in propanol with the rest consisting of methlycyclopentane and methylcyclohexane in about equal proportion. The chlorophyll is here mostly in the form of a single solvate—that is, the shoulder toward shorter wavelengths is in evidence. When the temperature was lowered to 231°K, the Soret band of this solution took on reversibly the more symmetrical form *at longer wavelengths* depicted at the right side of this figure, which clearly is a composite of the Soret bands of the two alcoholates and is practically identical

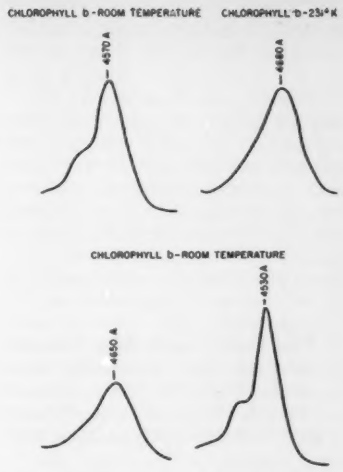

Fig. 2. (Bottom) Curves giving spectra of solutions of chlorophyll *b* at room temperature, in 100 percent n-propanol at left, and in 9 percent n-propanol, 45.5 percent methyl cyclopentane, and 45.5 percent methyl cyclohexane at right. (Top) Curves giving spectra of solution of chlorophyll *b* in 14 percent n-propanol, 43 percent methyl cyclopentane, and 43 percent methyl cyclohexane, at room temperature at left, and at 231°K at right.

with the Soret band of chlorophyll *b* in pure alcohol at room temperature in shape and wavelength. As was to be expected, the increased concentration of the higher solvate could be achieved either by a reduction in temperature or by an increase in concentration of the polar solvent at room temperature (*4*). By means of these two variables, it was possible then, by starting with a given solvent at a given temperature, to bring about a match in the spectra which chlorophyll exhibited when it was in either of the pure solvents at room temperature (*5*).

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4. The effect of the increase in concentration of alcohol is already observable in the spectrum of the solution 14 percent in propanol compared with that 9 percent in propanol. While the Soret band of the former exhibits a sloping shoulder toward short wavelengths, the shoulder of the latter still possesses the maximum characteristic of a single solvate.
5. This research was performed under the auspices of the U.S. Atomic Energy Commission. I am indebted to Donald G. Miller for assistance in taking the spectra.

28 March 1957

Book Reviews

A First Course in Analytic Geometry. Two and three dimensions treated simultaneously. H. Glenn Ayre and Rothwell Stephens. Van Nostrand, New York, 1956. 224 pp. Illus. $3.85.

This publication is a college mathematics textbook which presents plane and solid analytic geometry as a fused course. As the title suggests, it is intended for use in beginning courses. The authors offer the conventional topics that are found in most plane and solid analytic geometry textbooks, but the order of presentation and the approach to the topics are frequently quite different. To illustrate these differences, we find among chapter titles the following: "Directed lines," "The circle, sphere, cylinder, and cone," "The ellipse and the ellipsoid," "Other coordinate systems," "Functions and their graphs," "Empirical equations," and "Vectors and their applications in geometry."

The fusion of plane and solid analytic geometry is first accomplished through the sequence of directed lines, direction cosines, and direction numbers. Whenever plausible, proofs for the line and for the plane cases are followed by proofs in space. For example, the treatment of the distance between two points in one dimension is followed by the development of the formula for the distance between two points in two dimensions, and the proof is extended, in turn, to three dimensions. The study of the equation of a line in a plane precedes the consideration of the equation of a line in space. Both proofs follow a sequence in which direction numbers are used. One proof is the logical extension of the other. This pattern is evident throughout the book.

Since direction cosines are extensively used, the student observes an application of the trigonometric functions to coordinate geometry. The formula for the angle between two lines is developed by use of the unit circle and direction numbers. A short table of the trigonometric functions would be a worth-while addition to the appendix. There are enough exercises which require the use of such a table to warrant its inclusion.

This introductory textbook provides frequent groups of exercises and an adequate number of exercises in each group. Each set is accompanied by examples. The illustrative figures are carefully drawn, clearly labeled, and easy to relate to the explanations. Features such as these make this a very satisfactory textbook for classroom use.

The authors present a refreshing approach to analytic geometry for beginning college or superior high-school mathematics students. The terms are carefully defined and the sequence is logically organized. Perhaps the most praiseworthy feature of the book is the sound presentation of coordinate geometry in one, two, and three dimensions, each in reasonable and logical relationship with the other.

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The Great Chain of Life. Joseph Wood Krutch. Houghton Mifflin, Boston, 1957. 227 pp. Illus. $3.75.

Joseph Wood Krutch has written a thoughtful and thought-provoking book, in which he presents the reactions of a humanist to biology and to biologists. In the preface, he states that it is his purpose to examine the meaning of the statement that "man is like an animal." He addresses himself to that task by discussing certain aspects of the biology of a selected array of species. He begins with an extensive consideration of *Volvox*, which he discusses especially in relation to the origin of sexual reproduction and of natural death, in contrast to the potential physical immortality of unicellular animals. Social insects, especially the agricultural ants, are studied as examples of complex and efficient societies operating by automatic, instinctive mechanisms which permit neither understanding nor modification by the individual insect. Metamorphosis receives special attention in relation to the restriction of learning potential. The "barbarian mammal," exemplified by the mountain sheep, is described as being culturally far inferior to the social insects but as possessing some of our own psychological attributes. A salamander is discussed in connection with the very dim beginnings of that awareness which is the basis for the possibility of mental and emotional life.

Having made this survey, Krutch asks: "Have we been trying to understand the meaning of evolution by beginning at the wrong end?" Throughout, he is concerned primarily with evaluation in terms of human culture (but this is not crude anthropomorphism; rather, it is a conscientious and competent attempt to expose the crude mechanomorphism which, Krutch believes, is a common source of error for biologists). Thus he asks: "Why is a bungling mammal higher than an efficient wasp?" He believes that a biologist would feel obliged to treat the mammal as higher on morphological and other purely biological grounds (although I and many others would regard the mammal and the wasp as relatively high members of two lines of descent which are parallel rather than sequential; this would seem to make the question meaningless). Krutch believes that any answer to the question in terms of the usual sort of biological data must be irrelevant even if correct. In short, he maintains that we consider the mammal higher because we see in it some adumbration of our own mental life and of our own emotions and, possibly, even more than our own capacity to feel the joy of life, while in the insect we see none of these qualities. He believes that the emergence of such attributes in the "higher" animals requires a reexamination and, possibly, a revision of our ideas on evolution.

Krutch's data are not always good. His understanding of mitosis is largely erroneous; he puts the heyday of the ancient Amphibia in the Mesozoic rather than in the Paleozoic; nor has he always understood the objectives of biologists. For example, in decrying our lack of reverence for life, he says that "the more trivial the question . . . the more lives it is likely to cost . . . an earnest student shoots hundreds of birds . . . [in] proving that . . . some item in the pattern . . . is a millimeter greater in one geographical area than in another." Without claiming that collecting is never overdone, it may be mentioned that the purpose of such a study is not usually the demonstration of minute differences but the investigation of the mechanics of evolution, which is by no means trivial.

Such shortcomings, however, do no damage to the main argument of the book. It is obvious that Krutch has read much, observed much, and reflected deeply in the field of biology. His book deserves the thoughtful consideration of biologists generally.

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Chemical Engineering in the U.S.A. P. H. Calderbank. Department of Scientific and Industrial Research, Overseas Technical Reports No. 2. H.M. Stationery Office, London, 1956 (order from British Information Services, 45 Rockefeller Plaza, New York 20, N.Y.). 24 pp. $0.36.

This is the second of a series of surveys made by specialist officers attached to the United Kingdom Scientific Mission in Washington, D.C. The author, P. H. Calderbank, who is now with the Chemical Research Laboratory in England, spent some 4 months in the United States in 1955, during which time he visited a number of university and industrial establishments and had discussions with many people concerned with the selection, training, and employment of chemical engineers. His report deals with the development of chemical engineering, the present status of chemical engineering education, and the way in which chemical engineering practice has developed.

Electrical Measurements and Their Applications. Walter C. Michels. Van Nostrand, Princeton, N.J., 1957. 331 pp. Illus. $6.75.

The techniques of electric measurements have undergone substantial changes in the past 10 or 15 years. Part of this is the result of the great advances in electronic instrumentation which have made available, on a commercial basis, equipment of considerable stability and reliability, covering a tremendous range of frequencies, from direct current into the microwave region. The requirements of automation and automatic recording of technical information, furthermore, have extended the application of electric measurements into all fields of science and technology. To attempt to present an up-to-date textbook which covers the range of electric measurements, techniques, and instrumentation used today is, indeed, a challenging task. *Electrical Measurements and Their Applications* gives a surprisingly good survey of the situation. It is a revision of earlier editions by the same author (*Advanced Electrical Measurements, 1932, 1941*) but the changes in this book are sufficiently extensive to make it a successor to the earlier editions rather than just a new edition.

The book is prepared for junior and senior students in science and engineering, although it would also be a good reference book for the more advanced experimentalist. The first part, which consists of nine chapters, deals with basic ideas and with the instruments and techniques commonly found in electric measurements laboratories. The discussion starts with chapters on basic techniques of direct-current measurements. These are followed by chapters on phenomena at increasingly higher frequencies, concluding with one on microwave instrumentation and technique. In each chapter, detailed instructions are given for a number of experiments which illustrate, for the student, fundamental principles and techniques discussed in the chapter. A total of 43 experiments are described.

The second part of the book discusses applications of electric measurements in the fields of magnetism, thermometry, mechanics, acoustics, and nuclear physics. The treatment is necessarily brief but is accompanied by a number of references, to provide further detailed information. This section will be useful to the practicing engineer or scientist.

The book is well illustrated by photographs and diagrams of commercial instruments that are widely used today in industrial and government laboratories. The discussion of the operation of these instruments is limited to design features essential to their use.

In approximately 300 pages this book gives a condensed and lucid treatment of electric measurements as practiced in today's laboratories. It should serve as a valuable textbook in college electric-measurements courses and as a handy reference work for the advanced student or research scientist and engineer.

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Breads, White and Brown. Their place in thought and social history. R. A. McCance and E. M. Widdowson. Lippincott, Philadelphia, 1956. 174 pp. Illus. $5.

Breads, White and Brown is an admirable summary, covering 3000 years of the perennially moot question of the relative virtues or vices of white and brown breads. Perhaps the plagiarized title, "Through the alimentary canal with gun and camera," would not be descriptively amiss.

The historical development of white flour and its reflections of social conflicts and economic states is traced deftly through medieval and early modern England. With the advent of the newer knowledge of nutrition in the period of "peace and plenty" (1820–1914) and the period of "shortages and war" (1914–21), the proteins, minerals, and vitamins came into prominence. The extent to which the healthfulness of wheat is milled out in the manufacture of white flour became a crust of contention and political machinations throughout the "return to plenty" (1921–39) and World War II (1939–46) and indeed is still a lively subject.

The authors review the experimental work, the by-play of opinions and politics, and the differences in measures taken to resolve the problem, with fairness and considered judgment. From their own tests with children, described in some detail in chapter VIII, they conclude that bread has a much higher nutritional value than has been supposed, but no differences are notable in the value of whole meal, white flours, or white enriched flours.

So whatever the case, debate on the relative merits of white versus brown breads must go on, with forbearance and with considered judgment to express the diverse viewpoints of "people's health, the public's wishes, the nation's purse, or [the] shareholders' pockets."

This book is highly recommended for a well-balanced presentation of a difficult subject.

LEROY VORIS
National Research Council

Methods in Enzymology. vol. III. Preparation and assay of substrates. Sidney P. Colowick and Nathan O. Kaplan. Academic Press, New York, 1957. 1154 pp. $26.

Volume III of *Methods in Enzymology* furnishes the information on substrates that is needed for assay of the enzymes described in the previous two volumes. The series can now be used for much of the usual enzyme work without further recourse to the original literature. The present volume is thus an integral part of the previous ones and, in addition, presents methods for the preparation and determination of at least 200 compounds of general biochemical interest.

The organization of this vast amount of information follows that of volumes I and II. Volume III consists of seven sections: carbohydrates, lipids and steroids, citric acid cycle components, proteins and derivatives, nucleic acids and derivatives, coenzymes and related phosphate compounds, and determination of inorganic compounds. It should be noted that each article in volumes I and II gives the appropriate reference to volume III for the required substrate.

The presentation in most of the articles is up to the high standards of the previous volumes. However, this volume cannot be given the same unqualified recommendation. There are gaps in the methods described in several of the fields, which limit the usefulness of the book. To cite three examples which come to mind, no mention is made of

the use of dinitrophenylated derivatives for the quantitative paper chromatography of amino acids, the methods of Khorana for the synthesis of various phosphorylated compounds are not described, and the synthesis of optically active triose phosphates is omitted.

It may be that such omissions, and undoubtedly others, were unavoidable in view of the time and space that were available. When new methods appear so frequently, smaller, more specialized volumes are probably more useful. With these reservations, I feel that the book as a whole will undoubtedly be of great utility in any biochemical laboratory.

RICHARD S. SCHWEET
California Institute of Technology

New Books

Biology and Its Relation to Mankind. A. M. Winchester. Assisted by B. J. Kaston. Van Nostrand, Princeton, N.J., ed. 2, 1957. $7.25.

Progress in the Age of Reason. The 17th century to the present day. R. V. Sampson. Harvard University Press, Cambridge, Mass., 1956. 259 pp. $4.25.

The Changing Patient-Doctor Relationship. Martin G. Vorhaus. Horizon Press, New York, 1957. 310 pp. $3.95.

Social Theory and Social Structure. Robert K. Merton. Free Press, Glencoe, Ill., rev. ed., 1957. 663 pp. $7.50.

Dextran and Its Use in Colloidal Infusion Solutions. Anders Gronwall. Academic Press, New York, 1957. 156 pp. $4.

Handbuch der Physik, vol. XL. *Nuclear Reactions I.* S. Flügge, Ed. Springer, Berlin, 1957. 553 pp. DM. 128.

Nuclear Power Engineering. Henry C. Schwenk and Robert H. Shannon. B. G. A. Skrotzki, Ed. McGraw-Hill, New York, 1957. 335 pp. $6.50.

Recent Advances in Invertebrate Physiology, a Symposium. Sponsored by the National Science Foundation, the Tektronix Foundation, and the University of Oregon. Bradley T. Scheer, Ed. University of Oregon Publications, Eugene, 1957. 310 pp. $5.50.

Drug Resistance of Microorganisms. Robert J. Schnitzer and Emanuel Grunberg. Academic Press, New York, 1957. 409 pp. $10.

The Proceedings of the Third International Conference on Electron Microscopy, London 1954. V. E. Cosslett, chairman, Editorial Committee. R. Ross, General Ed. Royal Microscopical Society, London, 1956. 721 pp. $15.

The Physiology of Fishes, vol. I, *Metabolism.* Margaret E. Brown, Ed. Academic Press, New York, 1957. 460 pp. $12.

Neutron Transport Theory. R. B. Davison and J. B. Sykes. Clarendon Press, Oxford, 1957. 470 pp. $12.

Life. An introduction to biology. George G. Simpson, Colin S. Pittendrigh, and Lewis H. Tiffany. Harcourt, Brace, New York, 1957. 859 pp.

Rectifying Semi-Conductor Contacts. H. K. Henisch. Clarendon Press, Oxford, 1957. 384 pp. $11.20.

Semiconductor Abstracts, vol. III, *1955.* Abstracts of literature on semiconducting and luminescent materials and their applications. Compiled by Battelle Memorial Institute. Sponsored by the Electrochemical Society, Inc. E. Paskell, Ed. Wiley, New York; Chapman & Hall, London, 1957. 330 pp. $10.

Microwave Principles. Herbert J. Reich, John G. Skalnik, Philip F. Ordung, and Herbert L. Krauss. Van Nostrand, Princeton, N.J., 1957. 436 pp. $8.75.

Kinetics and Thermodynamics in Biochemistry. H. Geoffrey Bray and Kenneth White. Academic Press, New York, 1957. 355 pp. $7.50.

The Next Hundred Years. Man's natural and technological resources. A discussion prepared for leaders of American industry. Harrison Brown, James Bonner, and John Weir. Viking, New York, 1957. 193 pp. $3.95.

United States Army in World War II. The technical services. *The Signal Corps: the test* (December 1941 to July 1943). George Raynor Thompson, Dixie R. Harris, Pauline M. Oakes, and Dulany Terrett. Office of the Chief of Military History, Department of the Army, Washington, D.C. (order from Supt. of Documents, GPO, Washington 25), 1957. 636 pp. $4.50.

Mitochondria and Other Cytoplasmic Inclusions, No. X. Symposia of the Society for Experimental Biology. Published for the Company of Biologists on behalf of the Society for Experimental Biology by Academic Press, New York, 1957. 198 pp. $9.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

A Monograph on the Termitophilous staphylinidae (Coleoptera) Fieldiana: Zoology, vol. 40. Charles H. Seevers. Chicago Natural History Museum, Chicago, Ill., 1957. 334 pp. $6.50.

The Odonata of Louisiana. Tulane Studies in Zoology, vol. 5, No. 5. George H. Bick. Tulane University, New Orleans, La., 1957. 65 pp. $1.

Results of the Archbold Expeditions. No. 76. *A New Species of Wallaby (Genus Dorcopsis) from Goodenough Island, Papua.* American Museum Novitates, Number 1826. Hobart M. Van Deusen. American Museum of Natural History, New York, 1957. 25 pp.

Survey of Research Projects in the Field of Aviation Safety. Sixth annual supplement, January 1957. Harry F. Guggenheim, chairman. Daniel and Florence Guggenheim Aviation Safety Center at Cornell University, New York, N.Y., and Los Angeles, Calif., 1957. 114 pp.

Flora of Peru. Botanical Ser., vol XIII, pt. IIIA, No. 2. Publ. 808. J. Francis MacBride. Field Museum of Natural History, Chicago, 1956. 555 pp. $5.50.

Subject Index of School of Aviation Medicine Research Reports. January 1942–December 1956. Air University, School of Aviation Medicine, USAF, Randolph AFB, Texas, 1957. 72 pp.

Summaries of Studies in Agricultural Education. An annotated bibliography of studies in agricultural education with classified subject index. Vocational Div. Bull. No. 265, Agr. Ser. No. 69. Supplement No. 10 to Vocational Div. Bull. No. 180. U.S. Office of Education, Washington, 1957 (order from Superintendent of Documents, Government Printing Office, Washington 25, D.C.). 94 pp. $0.45.

Electromyographic Factors in Aircraft Control. Experimental investigation of the effect of a muscle tension reflex upon simple instructed movements. Rept. No. 55–123. R. C. Davis. 1956. 21 pp. *Electromyographic Factors in Aircraft Control.* Muscular activity during steady noise and its relation to instructed responses evoked by visual signals. Rept. No. 55–126. R. C. Davis. 1957. 9 pp. *Electromyographic Factors in Aircraft Control.* Muscular tensions during simultaneous performance of two tasks and their effect on performance. Rept. No. 55–128. R. C. Davis. 1956. 14 pp. *Electromyographic Factors in Aircraft Control.* The development and loss of a muscle tension set to an incidental stimulus. Rept. No. 55–130. John Benson Fink. 1956. 15 pp. *Electromyographic Factors in Aircraft Control.* The effect of induced tension upon muscular activity during simple voluntary movement. Rept. No. 55–133. Rollin M. Patton. 1957. 20 pp. *Electrocardiographic Observations on Ten Subjects at Sea Level and during One Year of Residence at High Altitude.* Rept. No. 56–98. Dante Peñaloza. 1956. 12 pp. *Maximal Diffusing Capacity of the Lungs at High Altitudes.* Rept. No. 56–108. Tulio Velásquez. 1956. 9 pp. *Comparative X-ray Dosimetry.* Rept. No. 56–109. Sanford C. Sigoloff, Loren C. Logie, Henry M. Borella, John C. Tourville. 1957. 4 pp. *The Development and Validation of a Checklist for Measuring Subjective Fatigue.* Rept. No. 56–115. Richard G. Pearson and George E. Byars, Jr. 1956. 16 pp. *Spectrophotometric Characterization of Light-Induced Changes in Autopolymerizing Resins.* Effect of ultraviolet light upon plastic specimens containing excess liquid. Rept. No. 56–124. Bertram Eichel, Theodore E. Fischer, John E. Sartore, Byron G. Butt. 1956. 5 pp. *Probability and Statistics in Item Analysis and Classification Problems.* Statistical decision theory approach to item selection for dichotomous test and criterion variables. Rept. No. 56–139. Howard Raiffa. 1957. 76 pp. *Evaluation of a Rapid (Hemoglobin Reduction) Method for Determining Antibiotic Susceptibility of Microorganisms.* Rept. Nos. 57-5 to 57-10. Joseph A. Bass, Frank B. Engley, Roland B. Mitchell, T. G. Blocker, Jr. 1956. 23 pp. *Human Stress Response in Jet Aircraft Operations.* Rept. No. 57-16. Thaddeus J. Domanski. 1956. 4 pp. *Metabolic Patterns of Selected Members of the Genus Lactobacillus.* Potassium uptake studies. Rept. No. 57–18. Ira L. Shannon and Norman O. Harris. 1957. 6 pp. *Direct Photometry of Diffusing Precipitin Systems for Characterizing Proteins.* Rept. No. 57-37. William G. Glenn. 1957. 5 pp. Air University, School of Aviation Medicine, USAF, Randolph Air Force Base, Tex.

Meetings and Societies

Nerve Cells

The Institute of Neurology and Brain Research, located in the mountains, 5000 feet above sea level, near Caracas, Venezuela, was host to about 40 scientists from different countries, 15–22 Mar. The conference, a symposium on "Submicroscopic Organization and Function of Nerve Cells," brought together, for intimate discussion, the fields of cell ultrastructure, neurochemistry, and neurophysiology. The plan of uniting these diverse fields was entirely successful because of the enthusiastic participation of the guests and of the members of the host institution.

The participants included V. L. van Breemen, G. C. Causey, H. Engström, H. Fernández-Morán, J. B. Finean, H. S. Gasser, J. H. Luft, S. L. Palay, K. L. Porter, E. De Robertis, H. Ruska, and F. O. Schmitt, who reported on ultrastructure studies by different methods; G. H. Bourne, R. Couteaux, J. Folch-Pi, L. C. U. Junqueira, H. Hydén, L. E. Roth, J. Runnstrom, T. Teorell, and G. Wald, who dealt with biochemical, physicochemical, and general cell physiology; and H. Autrum, C. G. Bernhard, T. H. Bullock, A. Forbes, R. Jung, S. W. Kuffler, R Lorente de Nó, D. P. C. Lloyd, P. Mueller, E. F. MacNichol, Jr., A. von Muralt, H. Olivecrona, D. Ottoson, G. Svaetichin, J. W. Woodbury, and Y. Zotterman, who discussed neurophysiology. The proceedings will be published by the Society of Cell Biology, under the editorship of R. Brown, of the University of Oxford.

In addition to the scientific activities, there was a good opportunity to inspect some parts of the rapidly expanding technologic developments of Venezuela and to form an opinion of the changing pattern of life in the country.

The institute, which has been in operation for only about 1 year, has already developed into a promising international center under the able and imaginative leadership of its director, Humberto Fernández-Morán. The exceedingly rapid progress in construction of facilities has been matched by scientific advances. There is an active program in electron microscopy, x-ray diffraction, nuclear magnetic resonance spectrometry, low-temperature research, and electrophysiology. The workshop facilities and technical installations are all excellent. A nuclear research reactor is now being constructed. The present laboratories constitute a pilot plant, and many more developments are planned. These new scientific expansions in South America should be welcomed by the international scientific community. It is to be hoped that scholarly scientific inquiry and the atmosphere of a free and independent intellectual life will develop, together with the rapidly advancing new technology of Venezuela.

STEPHEN W. KUFFLER
Wilmer Institute, Johns Hopkins Medical School, Baltimore, Maryland

Society Elections

■ American Society for Testing Materials: pres., Richard T. Kropf, Belding Heminway Company, Inc., New York, N.Y.; v. pres., F. L. LaQue, International Nickel Company, Inc., New York, N.Y. The directors are C. L. Clark, metallurgical engineer, Timken Roller Bearing Company, Steel and Tube Division, Canton, Ohio; A. E. Juve, director, Technical Services Research, B. F. Goodrich Company, Brecksville, Ohio; J. H. Koenig, director, School of Ceramics, Rutgers University, New Brunswick, N.J.

■ Hawaiian Academy of Science: pres., Andrew W. Lind, University of Hawaii, Honolulu; pres.-elect, Doak C. Cox, Hawaiian Sugar Planters' Association, Honolulu; sec., Sterling Wortman, Plant Breeding Department, Pineapple Research Institute, P. O. Box 3166, Honolulu, Hawaii; treas., Eleanor S. Anderson, Bernice P. Bishop Museum, Honolulu, Hawaii.

■ American Ceramic Society, Inc.: pres., John F. McMahon, State University of New York at Alfred University; pres.-elect, R. S. Bradley, A. P. Green Fire Brick Co.; treas., Andrew Pereny, Pereny Equipment Co., 893 Chambers Rd., Columbus, Ohio. The vice presidents are C. H. Hahner, W. A. Deringer, and J. S. Nordyke. Representative to the AAAS Council is Louis Navias.

■ National Council of Teachers of Mathematics: pres., Howard F. Fehr, Teachers College, Columbia University, New York, N.Y.; past pres., Marie S. Wilcox, Thomas Carr Howe School, Indianapolis, Ind.; v. pres. for high school, Donovan A. Johnson, University of Minnesota High School, Minneapolis, Minn.; v. pres. for elementary, Laura K. Eads, Board of Education, City of New York, Brooklyn 1, N.Y.; v. pres. for college, Robert E. Pingry, University of Illinois, Urbana; v. pres. for junior high school, Alice M. Hach, Public Schools, Racine, Wis.; recording sec., Houston T. Karnes, Department of Mathematics, Louisiana State University, Baton Rouge 3. The representative on the AAAS Council is Veryl Schult, Sheraton-Park Hotel, Washington, D.C.

■ American Psychosomatic Society: pres., Theodore Lidz; pres.-elect, Milton Rosebaum; sec.-treas., Morton F. Reiser, American Psychosomatic Society, 551 Madison Avenue, New York 22, N.Y.

■ National Association of Boards of Pharmacy: pres., Felix Blanc, Pharmacy Commission of Connecticut, Hartford, Conn.; hon. pres., William H. McNeill, Midland Park, N.J.; v. pres., Melvin G. Howe, Ft. Sumner, N.M.; treas, P. J. Hauper, Union Grove, Wis.; sec. and AAAS Council repr., P. H. Costello, American Council on Pharmaceutical Education, Chicago, Ill.

■ American Institute of the City of New York: pres., Robert F. Light; v. pres. and AAAS Council repr., Morris Meister; sec., Natalie Palmer; treas., Ralph H. Cheney; asst. treas., Charles A. Tonsor.

■ American Physiological Society: pres., L. N. Katz, Michael Reese Hospital, Chicago, Ill.; pres.-elect, Hallowell Davis, Central Institute for the Deaf, St. Louis, Mo.; past pres., A. C. Burton, University of Western Ontario, London, Ont., Canada; exec. sec.-treas., Ray G. Daggs, 9650 Wisconsin Ave., Washington 14, D.C.

Forthcoming Events

July

21–28. Neurological Sciences, 1st internatl. cong., Brussels, Belgium. (P. Bailey, National Institutes of Health, Bethesda 14, Md.)

23–24. Modern Electrochemical Methods of Analysis, Internatl. symp., Paris, France. (G. Charles, Ecole Superieure de Physique et de Chimie, 10, rue Vauquelin, Paris 5e.)

25–26. Structure Properties Relationships of Polymers (IUPAC), Paris, France. (International Union of Pure and Applied

Chemistry, 4, Avenue de l'Observatoire, Paris 6e.)

25–29. Protein Chemistry Symp., IUPAC, Paris, France. (J. Roche, College de France, Place Marcellin Berthelot, Paris 5e.)

26–27. Experimental Psychology and Animal Behavior Section of International Union of Biology, Brussels, Belgium. (H. S. Langfeld, Dept. of Psychology, Princeton Univ., Princeton, N.J.)

26–27. Linguistic Soc. of America, Ann Arbor, Mich. (A. A. Hill, Box 7790, University Station, Austin 12, Tex.)

26–27. Military Psychology, internatl. symp., Brussels, Belgium. (National Academy of Sciences, 2101 Constitution Ave., NW, Washington 25.)

26–31. International Humanist and Ethical Union, 2nd cong., London, England. (American Humanist Assoc., Gate House, Yellow Springs, Ohio.)

26–1. International Congress on Nutrition, 4th, Paris, France. (Quatrième Congrès International de Nutrition, CNERNA, 71, boulevard Péreire, Paris 17e.)

27–3. Religion in the Age of Science, 4th annual, Star Island, Isles of Shoals, Portsmouth, N.H. (Mrs. R. Holt, Box 156, Pennington, N.J.)

28–1. Psychoanalysis, 20th internatl. cong., Paris, France. (Dr. Nacht, 187, rue Saint-Jacques, Paris 5.)

28–3. Psychology, 15th internatl. cong., Brussels, Belgium. (L. Delys, 296, avenue des Sept Bonniers, Forest-Bruxelles.)

31–5. International Assoc. for Hydraulic Research, Lisbon, Portugal. (M. Coelho Mendes da Rocha, Laboratorio Nacional de Engenharia Civil, Avenida do Brasil, Lisbon.)

31–6. Dermatology, 11th internatl. cong., Stockholm, Sweden. (C. H. Floden, Hudkliniken, Karolinska Sjukhuset, Stockholm 60.)

August

2–3. Pennsylvania Acad. of Science, Honesdale, Pa. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

5–11. Pan American Cong. of Pediatrics, 5th, Lima, Peru. (C. F. Krumdieck, Washington 914, Lima.)

5–17. Curare and Curare-Like Agents, internatl. symp., Rio de Janeiro, Brazil. (C. Chagas, Instituto de Biofisica, Universidade do Brasil, 458 Avenida Pasteur, Rio de Janeiro.)

6–9. Poultry Science Assoc., annual, Columbia, Mo. (C. B. Ryan, Texas A.&M. College, College Station.)

7–9. Industrial Applications of X-Ray Analysis, 6th annual conf., Denver, Colo. (J. P. Blackledge, Metallurgy Div., Denver Research Inst., Univ. of Denver, Denver 10.)

7–9. International Union against the Venereal Diseases and the Treponematoses, 31st general assembly, Stockholm, Sweden. (Secretary General, Institut Alfred Fournier, 25, boulevard Saint-Jacques, Paris 14e, France.)

8–15. International Statistical Inst., 30th, Stockholm, Sweden. (Secretary General, ISI 30th Session, Fack, Stockholm 5.)

8–15. International Union for the Scientific Study of Population, Stockholm, Sweden. (F. Lorimer, c/o American University, Washington 16.)

11–14. Heat Transfer, national conf., University Park, Pa. (G. M. Dusinberre, Pennsylvania State Univ., University Park.)

11–17. World Federation for Mental Health, 10th annual, Copenhagen, Denmark. (Miss E. M. Thornton, 19 Manchester St., London, W.1, England.)

12–16. Canadian Teachers' Federation, annual, Edmonton, Alberta, Canada. (G. G. Croskery, 444 MacLaren St., Ottawa 4, Ont.)

12–18. Theory of Functions, internatl. colloquium, Helsinki, Finland. (B. Eckmann, Ecole Polytechnique, Federale, Zurich, Switzerland.)

12–25. International Soc. of Soil Mechanics and Foundation Engineering, 4th Conf., London, England. (A. Banister, Institution of Civil Engineers, Great George St., London, S.W.1.)

18–21. American Astronomical Soc., Urbana, Ill. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

19–21. National Council of Teachers of Mathematics, Northfield, Minn. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

19–22. American Veterinary Medical Assoc., annual, Cleveland, Ohio. (J. G. Hardenbergh, AVMA, 600 S. Michigan Ave., Chicago 5, Ill.)

19–23. Clay Conf., 6th natl., Berkeley, Calif. (Dept. of Conferences and Special Activities, Univ. of California Extension, Berkeley 4.)

19–23. Clinical Chemistry, 2nd international European cong., Stockholm, Sweden. (K. Agner, Box 12024, Stockholm 12.)

19–24. Finite Groups, internatl. colloquium, Tübingen, Germany. (H. Wielandt, Faculty of Mathematics and Natural Science, Eberhard-Karls-Universität, Tübingen.)

19–24. High Energy Physics Symp., Oak Ridge, Tenn. (University Relations Div., Oak Ridge Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge.)

19–24. New England Assoc. of Chemistry Teachers, 19th summer conf., Waterville, Maine. (Rev. J. A. Martus, College of the Holy Cross, Worcester 10, Mass.)

19–24. Origin of Life, internatl. symp., Moscow, U.S.S.R. (G. A. Deborin, Inst. of Biochemistry, U.S.S.R. Acad. of Sciences, B. Kaluzskaya 33, Moscow, B.71.)

20–22. Liquid Scintillation Counting Conf., Evanston, Ill. (C. G. Bell, Jr., Technological Inst., Northwestern Univ., Evanston.)

20–23. Western Electronic Convention, annual, San Francisco, Calif. (D. B. Harris, Electron Tube Research, General Electric Microwave Lab., Palo Alto, Calif.)

21–24. Pi Lambda Theta, New York, N.Y. (C. Johnson, Pi Lambda Theta, 307 Portland Bldg., 1129 Vermont Ave., NW, Washington 5.)

22–5. International Scientific Radio Union, 12th general assembly, Boulder, Colo. (K. A. Norton, Boulder Laboratories, National Bur. of Standards, Boulder.)

24–26. International Soc. for Biological Rhythm, 6th conf., Semmering, Austria. (A. Sollberger, Anatomical Department, Karolinska Institutet, Stockholm 60, Sweden.)

25–27. Pacific Division-AAAS, annual, in conjunction with American Inst. of Biological Sciences, Stanford, Calif. (R. C. Miller, California Academy of Sciences, Golden Gate Park, San Francisco, Calif.)

25–28. American Farm Economic Assoc., natl., Asheville, N.C. (L. S. Hardin, Dept. of Agricultural Economics, Purdue Univ., Lafayette, Ind.)

25–29. American Institute of Biological Sciences, annual, Stanford, Calif. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

The following 28 meetings are being held in conjunction with the AIBS meeting at Stanford, Calif.

American Bryological Soc., annual. (W. C. Steere, Dept. of Biological Sciences, Stanford Univ.)

American Fern Soc., annual. (I. L. Wiggins, Dept. of Biological Sciences, Stanford Univ.)

American Microscopical Soc., annual. (G. M. Smith, Dept. of Biological Sciences, Stanford Univ.)

American Phytopathological Soc., annual (W. B. Hewitt, Dept. of Plant Pathology, Univ. of California, Davis). 26–28 Aug. only.

American Soc. for Horticultural Science, annual. (H. P. Olmo, Dept. of Viticulture, Univ. of California, Davis.)

American Soc. of Human Genetics. (E. J. Gardner, Dept. of Zoology, Utah State College, Logan.)

American Soc. of Ichthyologists and Herpetologists. (W. C. Brown, Menlo College, Menlo Park, Calif.)

American Soc. of Limnology and Oceanography. (D. E. Wohlschlag, Dept. of Biological Sciences, Stanford, Univ.)

American Soc. of Naturalists, annual. (D. Perkins, Dept. of Biological Sciences, Stanford Univ.)

American Soc. of Plant Physiologists, annual. (W. R. Briggs, Dept. of Biological Sciences, Stanford Univ.)

American Soc. of Plant Taxonomists, annual. (I. L. Wiggins, Dept. of Biological Sciences, Stanford Univ.)

American Soc. of Zoologists, annual. (J. F. Oliphant, Dept. of Biological Sciences, Stanford Univ.)

Biometric Soc., WNAR. (D. E. Wohlschlag, Dept. of Biological Sciences, Stanford Univ.)

Botanical Soc. of America, annual. (W. C. Steere, Dept. of Biological Sciences, Stanford Univ.)

Ecological Soc. of America, annual. (I. L. Wiggins, Dept. of Biological Sciences, Stanford Univ.)

Genetics Soc. of America, annual. (D. Perkins, Dept. of Biological Sciences, Stanford Univ.)

Mycological Soc. of America, annual. (R. M. Page, Dept. of Biological Sciences, Stanford Univ.)

National Assoc. of Biology Teachers. (Miss E. Larson, Box 2841, Carmel, Calif.)

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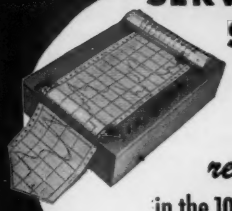

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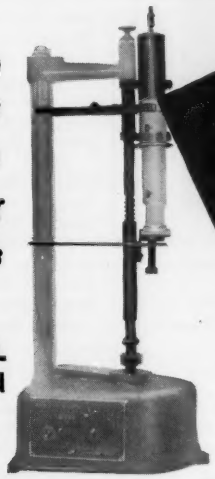

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Nature Conservancy, annual. (W. Drake, Canyon, Calif.)

Phycological Soc. of America, annual. (G. F. Papenfuss, Dept. of Botany, Univ. of California, Berkeley 4.)

Sigma Delta Epsilon. (Mrs. C. B. Parker, 7 Lloyd Rd., Malvern, Pa.)

Society for Experimental Biology and Medicine, Pacific Coast Section. (J. P. Baumberger, Dept. of Physiology, Stanford Univ.)

Society of General Physiologists. (D. Mazia, Univ. of California, Berkeley 4.)

Society for Industrial Microbiology, annual. (J. C. Lewis, Agricultural Research Service, USDA, 800 Buchanan St., Albany 10, Calif.)

Society for the Study of Evolution, annual. (R. W. Holm, Dept. of Biological Sciences, Stanford Univ.)

Society of Protozoologists, annual. (J. F. Oliphant, Dept. of Biological Sciences, Stanford Univ.)

Society of Systematic Zoology, Pacific section. (D. P. Abbott, Hopkins Marine Station, Pacific Grove, Calif.)

Western Soc. of Naturalists, annual. (W. M. Hiesey, Carnegie Institution of Washington, Stanford, Calif.)

26–28. Gas Dynamics Symp., 2nd, Evanston, Ill. (A. B. Cambel, Technological Inst., Northwestern Univ., Evanston.)

26–29. Boundary Layer Research, internatl. symp., Freiburg, Breisgau, Germany. (H. Görtler, Mathematisches Institut der Universität, Hebelstrasse 40 Freiburg, Breisgau.)

26–29. Mathematical Assoc. of America, 38th summer, University Park, Pa. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

26–30. American Mathematical Soc., 62nd summer, University Park, Pa. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

26–30. Infrared Spectroscopy Inst., 8th annual, Nashville, Tenn. (N. Fuson, Infrared Spectroscopy Inst., Fisk Univ., Nashville 8.)

26–31. Low Temperature Physics and Chemistry, 5th internatl. conf., Madison, Wis. (J. R. Dillinger, Dept. of Physics, Univ. of Wisconsin, Madison 6.)

27. Society for Industrial and Applied Mathematics, summer, University Park, Pa. (D. L. Thomsen, Jr., 807 Enquirer Bldg., Cincinnati 2, Ohio.)

27–29. American Sociological Soc., annual, Washington, D.C. (Mrs. M. W. Riley, ASS, New York Univ., Washington Sq., New York 3.)

27–30. Biological Photographic Assoc., 27th annual, Rochester, Minn. (S. J. McComb, Section of Photography, Mayo Clinic, Rochester.)

28–30. Gas Chromatography, internatl. symp., East Lansing, Mich. (H. J. Noebels, IGC Symp., Instrument Soc. of America, 313 Sixth Ave., Pittsburgh, Pa.)

28–31. Soil Conservation Soc. of America, annual, Asilomar, Calif. (H. W. Pritchard, 838 Fifth Ave., Des Moines 14, Iowa.)

28–3. Cell Biology, 9th internatl. cong., St. Andrews, Scotland. (H. G. Callan, Dept. of National History, Bell Pettigrew Museum, The University, St. Andrews, Fife.)

29–30. Computers and Data Processing, 4th annual symp., Denver, Colo. (J. M. Cavenah, Denver Research Inst., Univ. of Denver, Denver 10.)

29–30. Econometric Soc., European meeting, Luxemburg, Duchy of Luxemburg. (Econometric Soc., Box 1264, Yale Station, New Haven, Conn.)

29–31. Group Psychotherapy, 2nd internatl. cong., Zurich, Switzerland. (S. Lebovici, 3, Avenue President Wilson, Paris 16e, France.)

29–2. European Orthodontic Soc., annual, Genoa, Italy. (E. Fernex, 1, Place du Port, Genoa.)

29–3. International Geographical Cong., Tokyo, Japan. (W. W. Atwood, Jr., National Acad. of Sciences, 2101 Constitution Ave., Washington 25.)

30–5. American Psychological Assoc., annual, New York, N.Y. (R. W. Russell, APA, 1333 16 St., NW, Washington 6.)

31–2. Astronomical League, annual, Kansas City, Mo. (Mrs. W. A. Cherup, 4 Klopfer, Pittsburgh 9, Pa.)

31–3, Psychometric Soc., annual, New York, N.Y. (P. DuBois, Dept. of Psychology, Washington Univ., St. Louis, Mo.)

September

1–6. Laurentian Hormone Conf., AAAS, Mont Tremblant, Quebec, Canada. (G. Pincus, LHC, 222 Maple Ave., Shrewsbury, Mass.)

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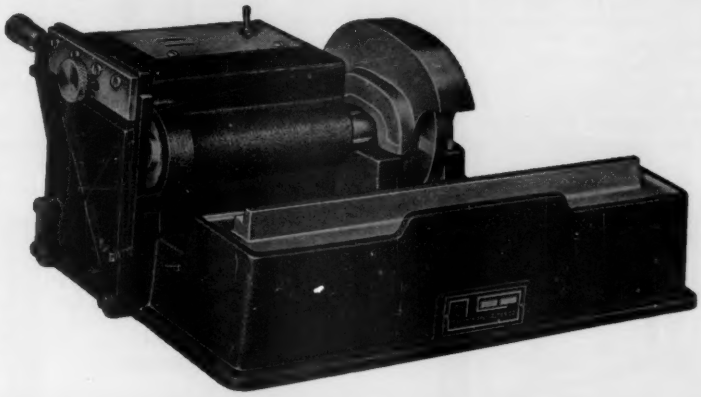

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1–7. Psychiatry, 2nd world cong., Zurich, Switzerland. (J. Wyrsch, Tottikon, Stans, Nidwald, Switzerland.)

1–16. Aeronautical Conf., 6th internatl., London and Folkestone, Kent, England. (S. P. Johnston, Inst. of Aeronautical Sciences, 2 E. 64 St., New York 21.)

2. Meteoritical Soc., 20th annual, Los Angeles, Calif. (J. A. Russell, 3518 University Ave., Los Angeles 7.)

2–5. American Physiological Soc., Iowa City, Iowa. (M. O. Lee, 9650 Wisconsin Ave., Washington 14.)

2–5. Passivity, internatl. symp., Darmstadt, Germany. (German Bunsen Gesellschaft, Postfach 11, Duisburg, Germany.)

2–6. Operational Research, internatl. conf., Oxford, England. (T. Page, 7100 Connecticut Ave., Chevy Chase, Md.)

2–16. Carbon-14 Dating, 3rd internatl. conf., in conjunction with INQUA, Madrid-Barcelona, Spain. (M. Rubin, U.S. Geological Survey, Washington 25.)

2–16. International Assoc. on Quarternary Research, 5th internatl. cong., Madrid-Barcelona, Spain. (M. L. Solé Sabarís, Instituto Geológico, Universidad, Barcelona.)

3–6. Calorimetry Conf., 12th, Wentworth-by-the-Sea, N.H. (H. A. Boorse, Pupin Physics Lab., Columbia Univ., New York, N.Y.)

3–6. Matrix Computations Conf., Detroit, Mich. (W. Givens, Dept. of Mathematics, Wayne State Univ., Detroit 2.)

3–14. International Union of Geodesy and Geophysics, 11th general assembly, Toronto, Ont., Canada. (J. A. Jacobs, 49 St. George St., Toronto.)

4–5. Society of General Physiologists, annual, Woods Hole, Mass. (A. M. Shanes, National Institutes of Health, Bethesda 14, Md.)

4–6. Latency and Masking in Viral and Rickettsial Infections, symp., Madison, Wis. (A. S. Evans, Div. of Preventive Medicine, Univ. of Wisconsin Medical School, Madison 6.)

4–6. Magnetic Amplifiers, technical conf., Pittsburgh, Pa. (G. F. Pittman, Jr., Westinghouse Electric Corp., P. O. Box 10596, Pittsburgh 35.)

4–11. British Assoc. for the Advancement of Science, 119th annual, Dublin, Ireland. (Secretary, BAAS, Burlington House, London, W.1, England.)

5–7. American Political Science Assoc., natl., New York, N.Y. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

6–12. Medicine and Social Hygiene, internatl. symp., Trieste. (M. Lovenati, via Cavana 18, Trieste.)

7–14. Odontostomatology, 12th internatl. cong., Rome, Italy. (G. Corradi, 16 via Boezio, Rome.)

7–14. Sociology, 17th internatl. cong., Beirut, Lebanon. (G. Gini, via Adige 39, Rome, Italy.)

8–12. International College of Surgeons, 22nd annual, Chicago, Ill. (K. A. Meyer, ICS, 1516 Lake Shore Dr., Chicago 10.)

8–13. American Assoc. of Clinical Chemists, annual, New York, N.Y. (M. M. Friedman, Lebanon Hospital, New York 57.)

8–13. American Chemical Soc., New York, N.Y. (A. H. Emery, ACS, 1155 16 St., NW, Washington 6.)

8–13. Nuclear Structure, internatl. conf. (IUPAP), Rehovoth, Israel. (A. de Shalit, Weizmann Inst. of Science, Rehovoth.)

8–15. International Cong. of Crop Protection, 4th, Hamburg, Germany. (Biologische Bundesanstalt für Land- und Forstwirtschaft, Messeweg 11–12, Braunschweig, Germany.)

9–11. Electron Microscope Soc. of America, annual, Cambridge, Mass. (D. M. Teague, Chrysler Corp., Box 1118, Detroit 31, Mich.)

9–11. Quantitative Methods of Mammalian Cell Culture, 2nd annual, Denver, Colo. (Office of Graduate and Postgraduate Education, Univ. of Colorado Medical Center, Denver 20.)

9–13. Illuminating Engineering Soc., annual, Atlanta, Ga. (A. D. Hinckley, IES, 1860 Broadway, New York 23.)

9–13. Instrument Automation Conf., 12th annual, Cleveland, Ohio. (Instrument Soc. of America, 313 Sixth Ave., Pittsburgh, Pa.)

9–14. Clinical Chemistry, internatl. cong., New York, N.Y. (J. G. Reinhold, 711 Maloney Bldg., Univ. of Pennsylvania, Philadelphia 4.)

9–15. Macromolecular Chemistry, internatl. symp., IUPAC, Prague, Czechoslovakia. (Secretariat, ISMC, 5, Technická, Prague 6.)

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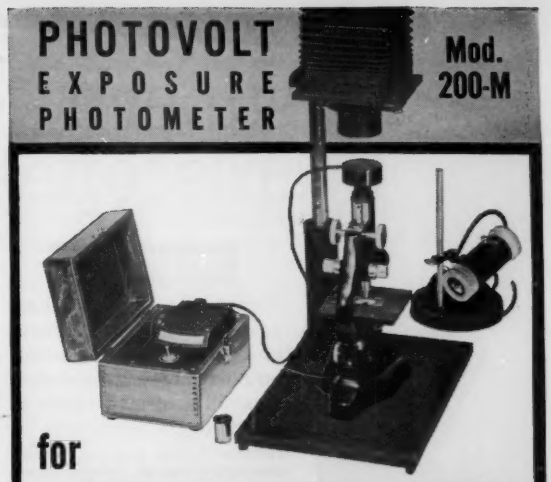

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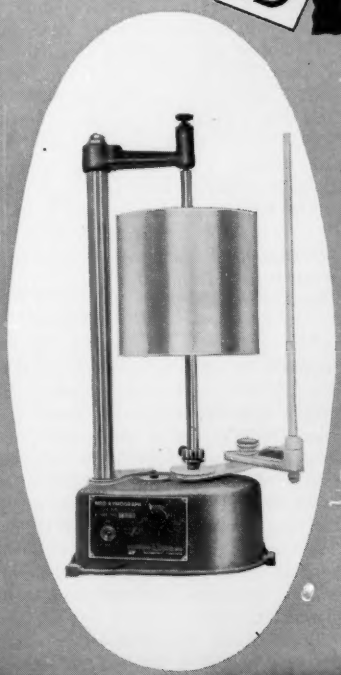

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LETTERS

The editors take no responsibility for the content of the letters published in this section. Anonymous letters will not be considered. Letters intended for publication should be typewritten double-spaced and submitted in duplicate. A letter writer should indicate clearly whether or not his letter is submitted for publication. For additional information, see Science **124**, *249 (1956) and* **125**, *16 (4 Jan. 1957).*

Russian Translation

Apparently the story of the $250,000 that was lost because of a Russian paper on Boolean matrix algebra and relay contact networks "which appeared in an important, readily available Soviet journal" and "simply reposed on a library shelf waiting to be noticed" [R. E. O'Dette, *Science* **125**, 580 (1957), quoting W. N. Locke, *Sci. American* **194**, No. 1, 29 (1956)] is going to be one of the indestructible legends of our time. Perhaps there is no point in attempting to impede its triumphant progress. However, as E. H. Cutler has pointed out [*Sci. American* **194**, No. 3, 6 (1956)], this is hardly a case where more translation would have helped significantly; the paper was abstracted in *Mathematical Reviews*, indeed by a staff member of the Bell Telephone Laboratories, and was indexed in the annual subject index. If people interested in the subject had been on their toes, they would have been watching the relevant section of *Mathematical Reviews*, where papers on similar topics have been, and still are, regularly abstracted.

Since I was the executive editor of *Mathematical Reviews* when the paper in question was published and had the responsibility for noticing it and seeing that it was reviewed, I cannot help but feel that if people are unable or unwilling to use the bibliographic aids that are already provided, there is little point in supplying them with even more in the form of translations and so on.

R. P. Boas, Jr.
Department of Mathematics,
Northwestern University,
Evanston, Illinois

My apologies to R. P. Boas, Jr., as well as to any other reader who may have reacted similarly. I was not pointing fingers. I cited the illustration, which still seems valid to me, to make three, and only three, points: (i) Soviet information is often important; (ii) it is often available; and (iii) it may be both simultaneously. It is doubtful that all United States scientists are equally aware of the possible significance of the Russian literature, although awareness seems to be increasing.

Locke stated that translation might not have helped in the Boolean algebra "legend." Whether or not "more trans-

lation would have helped significantly" is a good but unanswerable question. Possibly one might calculate the probability of faster absorption of Lunts' contribution as a function of increasing reader exposure to the paper or reviews of it in various formats and different media. For example, what would have happened if Gibbs' phase rule papers had first appeared in a more widely read journal? Or if Gosio's 1896 paper, which noted the antibiotic properties of a *Penicillium* strain, had appeared in *Science* instead of in an Italian sanitary engineering journal?

National Science Foundation support of translations projects stems from the belief that the odds in favor of starting another "Lunts legend" are lessened for papers that appear in the translated journals. Thus, while I join sincerely with Boas in wondering what one does next if scientists do not use existing bibliographic aids, I do not think that doing nothing is the answer. This is one reason for the translation program.

RALPH E. O'DETTE
National Science Foundation, Washington, D.C.

Biological Clock

I consider LaMont C. Cole's "Biological clock in the unicorn" [*Science* **125**, 874 (3 May 1957)] to be one of the great papers in science—in its absolute logical rigor and its straight-faced whimsy, in its demonstration of the meaning of a model and of a general theorem, and in its delicious deep sense-nonsense language. Congratulations and thanks for what is the best and most useful demonstration of really strict method I have yet seen and the most useful teaching tool with clients and students, especially with clients who think that they are scientists because they quantify.

PETER F. DRUCKER
138 North Mountain Avenue, Montclair, New Jersey

Literature, Science, and Manpower

The article "Literature, science, and the manpower crisis," by Joseph Gallant [*Science* **125**, 787 (26 Apr. 1957)], is one of the most disturbing pieces of rationalization I have seen in a long time. His thesis would seem to be that since almost everything written was considered "literature" (by some) in 1858, we may now readopt that position, with the curious reversal of tossing aside everything that is not science.

What Gallant apparently fails to understand, or does not wish to see, is the difference between "literature" (which may include even advertising) and a literary work. Perhaps he also fails to recognize the fact that already our college freshmen arrive knowing nothing of Shakespeare, nothing of Milton—nothing, in fact, of any of the literary points of human reference that one might expect even a scientist to have at his disposal. It is obvious that high-school courses in English need drastic revision, but should this be in the direction of *Life on Other Worlds*? Is the function of an English course to provide propaganda for the sciences?

Why, I wonder, do teachers of science not make greater use of the kind of "literature" Gallant lists at such length? Perhaps they are too busy teaching science. But if they *do* make use of such books, let us keep in mind that *The Sea around Us* is likely to seem merely a "factual" document unless one goes at it with an awareness of those points of reference mentioned above.

CARL F. HARTMAN
Department of English, Washington University, St. Louis, Missouri

In their reviews in today's *New York Times Book Section* (26 May), two contemporary poets wrote, unwittingly to be sure, replies to Carl F. Hartman's strictures. William Meredith, Hudson Review fellow in poetry, said: "Poetry cannot meet honestly with its subject except in the language of its time. No contemporary poet can feel deeply in a language whose problems and tensions are, for him, synthetic. It is in the nature of art that to be an artist at all one must be a modern artist."

W. S. Merwin said: "We delight in the Cavalier poets without blaming them for not having written *Anthony and Cleopatra*."

In the house of literature there are many mansions, including, in our own time, *The Sea around Us*, which by its virtues as literature need not displace the mansion of Milton.

On the pedagogic side, our objective today is to endow students with a passion for reading and for things of the mind so that they may, among other intellectual pursuits, read Shakespeare and Milton with insight and not as mere ritual. It was the thesis of my article that this objective can be attained by a broader definition of literature, by no means restricted to science literature, but embracing works which offer fresh, individualized, and imaginative perspectives in any area of human interest, theology and history no less than science. However, science is particularly potent as a source of imaginative stimulus; it is peculiarly neglected as *reading*, and it is *needed* with particular urgency by the citizen of the 20th century.

JOSEPH GALLANT
Department of English, Theodore Roosevelt High School, New York, N.Y.

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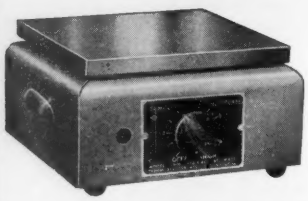

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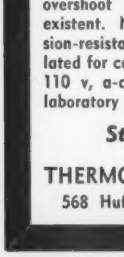

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■ TRAINING REACTOR designed to meet the needs of nuclear engineering curricula in colleges and universities is described in a 16-page brochure. The information given includes specifications, a cutaway view of the reactor, and a typical layout for arrangement of facilities. (American-Standard Corp., Dept. S369)

■ OSCILLOSCOPE of modular design is comprised of interchangeable amplifiers, sweep generators, power supplies, and basic cathode-ray tube. Features of the instrument are direct-reading amplitude and time calibrations, sweep expansion, and driven and recurrent sweeps. Modules may be purchased individually or preassembled into high- or low-frequency units. (Advanced Electronics Manufacturing Corp., Dept. S371)

■ DROP COUNTER can be set to select samples of up to 400 drops per sample. The counter operates by using the lens action of the drop to diminish illumination falling on a photocell. Very low illumination intensity is used in order to avoid heating effects on slow-forming drops. An optional multiplier control increases the capacity of the instrument to 800 drops. (National Instrument Laboratories, Inc., Dept. S378)

■ DIGITAL VOLTMETER provides an accuracy of ± 0.05 percent, according to the manufacturer. Measurements are made automatically and are presented with 1-in.-high lighted numerals arranged in line. Linearity is better than 0.01 percent from 1 mv to 1000 v, direct current. The decimal point is automatically positioned for the maximum number of significant figures under all conditions. Average balance time is 1 sec. (Electro Instruments Inc., Dept. S379)

■ DRIVE UNIT for pharmaceutical devices is available with 14 attachments, including a three-roller mill, a tablet coater, and others. The apparatus is designed for laboratory use. (Chemical and Pharmaceutical Industry Co., Inc., Dept. S388)

■ RELATIVE HUMIDITY CHAMBER provides a two-point humidity cycling program. A timer transfers control alternately between a high-point and a low-point controller. The work chamber is an inverted Pyrex jar 12 in. high and 18 in. in diameter. Dry-bulb temperature is variable from room temperature to 170°F, and relative humidity is controlled from 20 to 99 percent with accuracy of ± 1 percent. (Blue M Electric Company, Dept. S382)

■ BLOCKING OSCILLATOR, encapsulated within a ¾-in. cube, produces a pulse of 3-μsec duration with a rise time of 0.06 μsec. Amplitude is from + 6 v peak to − 3 v peak. Repetition rates of 25 kcy/sec, 1 kcy/sec, or variable from 400 cy/sec to 24 kcy/sec are offered. Input to the oscillator is 6-v direct current. (Allen B. DuMont Laboratories, Inc., Dept. S390)

■ THERMOCOUPLE WELDER is a miniature model for use in resistance-welding thermocouple junctions and leads and for securing thermocouples, strain gages, thermistors, and other devices to large bodies. A built-in power supply operates on 115-v alternating current. (Ewald Instruments, Dept. S393)

■ REFLECTANCE UNIT for the DK-2 recording spectrophotometer houses an integrating sphere and necessary optical elements and detectors. Interchangeable source and detector compartments permit monochromatic illumination of the sample or direct illumination of the sphere and sample. The device measures total, diffuse, and specular reflectance, transmittance of clear or turbid samples, fluorescent samples, and source emission. (Beckman Instruments, Inc., Dept. S384)

■ STANDARD BLOOD SERUM serves as a control to check the accuracy of tests and techniques in blood chemistry. Samples are prepared by freeze-drying and are carefully analyzed by two laboratories; the reported values are the average of eight determinations. (Clinton Laboratories, Dept. S394)

■ CAMERA, designed primarily for meteorological use, covers a 180-deg angle of view. The entire celestial dome and 360 deg of horizon are included in the image. The camera uses No. 120 roll film. Negative size is 2¼ by 2¼ in. Focal length is 16 mm. Shutter speeds range up to 1/200 sec. (Nikon Inc., Dept. S387)

■ HIGH-SPEED ANGLE CENTRIFUGE incorporates a self-aligning device that causes the rotor to rotate about its actual center of gravity, thus compensating for machining allowances and imperfect balance. All models have been designed for continuous operation and may be used in refrigerators. Two styles of interchangeable rotors are provided, one holding eight tubes and the other 16 tubes. Operating speed is 14,000 rev/min. (Custom Scientific Instruments, Inc., Dept. S386)

■ DECADE COUNTER strip uses beam-switching tube to provide 1-μsec resolution. A single fast binary trigger is used to transfer the electron beam through each of the switching tube's ten states. Read-out is provided by panel neon lamps. A negative output pulse is provided to drive the next counting stage. Maximum continuous counting rate is greater than 450 kcy/sec. (Nuclear Chicago Corp., Dept. S398)

■ CARDIAC SPECTROGRAPH for the audio and subaudio range is especially designed for making analyses and permanent audible and visible records of heart sounds. The recording medium is a flexible magnetic disk, 12 in. in diameter and approximately 3 mils thick. The disk is removable for filing. Frequency range of the spectrograph is 10 to 1500 cy/sec, and the filter bandwidth is 23 cy/sec. Three displays are provided. One shows frequency versus energy versus time and is linear with respect to frequency and time; the second shows intensity versus frequency at five consecutive times; and the third shows average amplitude versus time. The displays are recorded on 5⅜- by 12¾-in. facsimile paper. (Kay Electric Co., Dept. C389)

■ TEMPERATURE CONTROL is said to provide accuracy of ±0.001°C. Three models are offered with ranges of −100° to +100°C, −3° to +225°C, and 200° to 500°C. A stainless-steel sheathed resistance thermometer is the temperature-sensing element. The electronic bridge circuit into which it feeds operates a mercury relay capable of handling power up to 1700 w. Operation is on 115-v, 60 cy/sec power. (Bayley Instrument Co., Dept. S402)

■ OSCILLOGRAPH PEN MOTOR has constant response from 0 to 60 cy/sec, falling off 12 db per octave from 60 to 200 cy/sec. Sensitivity is 20 ma r.m.s. full scale. Rectilinear motion of the pen tip is accomplished by a linkage assembly. Acoustic damping eliminates resonant peaks, overshoot, and ringing. The motor is designed for use in multichannel systems. (Massa Laboratories, Inc., Dept. S399)

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Paleontologist–Zoologist, Ph.D. 1946. Presently assistant professor of biology. Wishes to relocate, teaching or research. Publications. Box 196, SCIENCE. X

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(a) Anatomist, M.D., qualified to teach everything in this field; rank dependent qualifications. **(b) Microbiologist** qualified in virology or experimental immunology; medical school pediatric research department; South. **(c) Neurophysiologist** interested in problems of vision; association with group specializing in this field; opportunity important academic appointment. **(d) Pharmaceutical Chemist** to take charge of control laboratory and new product division, organization specializing biologicals and pharmaceutical products; Midwest. S6-3 Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

Biology. Instructor for temporary appointment beginning September 1957. General biology, zoological background preferred. Youth, enthusiasm, and M.S. required. Large southwestern university. Box 198, SCIENCE. 6/28; 7/5, 12

Director, diagnostic and research tuberculosis laboratory, central Florida, physician or nonphysician microbiologist or clinical chemist. Part-time employment will be considered. Write Dr. Albert V. Hardy, Director, Bureau of Laboratories, State Board of Health, P.O. Box 210, Jacksonville, Florida. uc

POSITIONS OPEN

Comparative Anatomist—Visiting Professor, retired or sabbatical, for fall semester 1957 only. Box 189, SCIENCE. 6/28; 7/5

Applications are invited for the positions of **HEADS OF THE DIVISIONS OF PHYSICS AND CHEMISTRY** of the Saskatchewan Research Council. Applicants should have a doctor's degree or its equivalent and 6 to 8 years' research experience, including 6 years in supervision of investigational work.

The field of interest of the Saskatchewan Research Council includes both pure and applied science but is mainly directed to matters affecting the economy of the Province. Within this field the work is widely diversified. The Council's laboratory building is now under construction on the grounds of the University of Saskatchewan and is expected to be ready for occupancy in April 1958. Applicants should be prepared to join the Council before that time in order to participate in planning the initial program of research.

Inquiries are to be addressed to Dr. T. E. Warren, Director, Saskatchewan Research Council, University of Saskatchewan, Saskatoon, Saskatchewan. 6/14, 21

Physician, not over 35, male; single or married. Experience not necessary; salary open. M.D. licensed in Illinois. Will accept M.D. who is eligible to receive license in Illinois. Applicant must have genuine interest in biologics and blood work. Training will be offered. Eventually can become associate director to present executive director. Box 192, SCIENCE. 6/28; 7/5, 12

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Box 185, SCIENCE

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Supervising Hospital Biochemist for a clinical chemistry laboratory of a large university hospital affiliated with a medical college; also teaching opportunity. Broad experience is required. Salary range, $7047 to $7830. Liberal personnel policies. Please address your communication indicating your background and experience to the Administration Office, Cincinnati General Hospital, 3231 Burnet Avenue, Cincinnati 29, Ohio. 6/21, 28; 7/5, 12, 19, 26; 8/2

POSITIONS OPEN

Scientist–Junior: M.S. or equivalent in organic chemistry and/or biochemistry. Some knowledge of patent procedures and foreign languages desirable to participate in the evaluation of foreign scientific information for a Philadelphia pharmaceutical manufacturer. Liberal benefit program. Send complete résumé. Box 188, SCIENCE. 6/21

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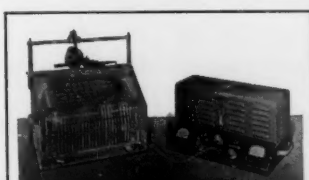

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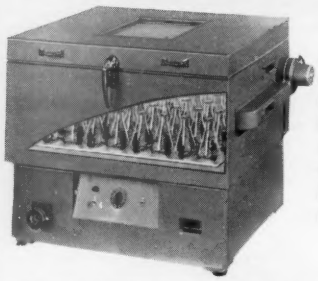

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Beta-Napthyl Acetate, and 6 Bromo-2-naphthyl acetate	Acetyl choline esterase
Sodium-6-Benzoyl 2-naphthyl phosphate	Phosphatase
2-(4-Hydroxybenzeneazo) Benzoic acid	Albumin in blood plasma
Carbonaphthoxy choline iodide	Serum choline esterase
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Indoxyl acetate	Esterase and acetyl choline esterase
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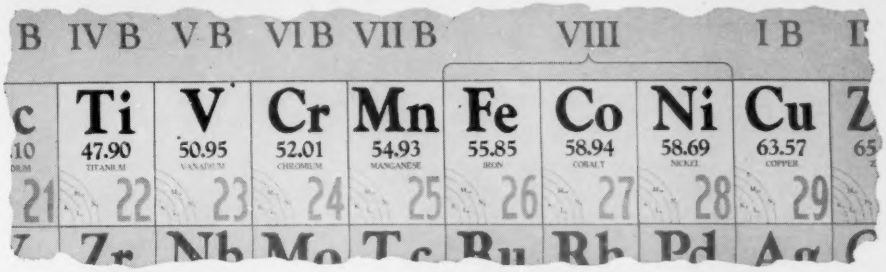
QUICK DETECTION OF PARAMAGNETIC IONS

E-P-R AT WORK **5**

(Electron Paramagnetic Resonance)


B IV B V B VI B VII B VIII I B
Ti 47.90 TITANIUM 22
V 50.95 VANADIUM 23
Cr 52.01 CHROMIUM 24
Mn 54.93 MANGANESE 25
Fe 55.85 IRON 26
Co 58.94 COBALT 27
Ni 58.69 NICKEL 28
Cu 63.57 COPPER 29

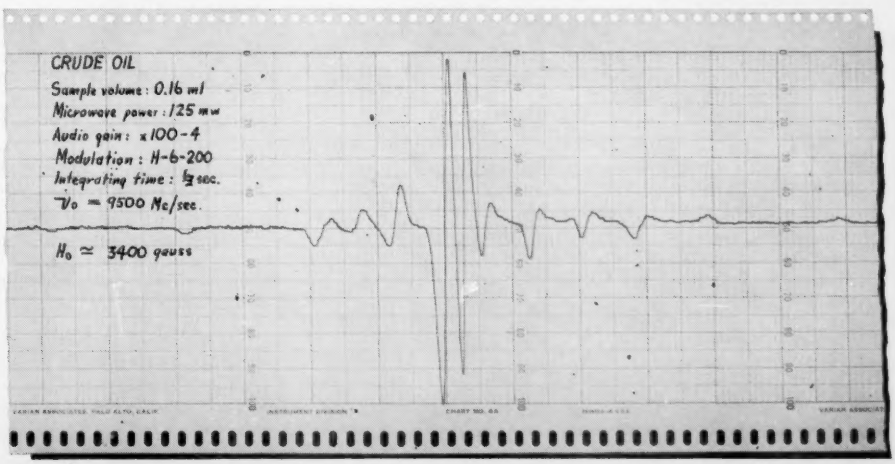
Where a trace of a transition element ion constitutes either a harmful impurity or a key to a chemical, physical or biological phenomenon, quantitative determination by E-P-R spectroscopy has a number of advantages. The test is fast and non-destructive. A typical sample size is 0.1 cc and the method is effective on concentrations as low as 10^{-6} molar. On a routine basis a quantitative E-P-R test can be made in a few minutes. The same results by chemical analysis might require hours or days of painstaking effort.

E-P-R Spectroscopy is effective on most transition element ions because the unfilled electronic shell causes the ion to be paramagnetic. Each ion yields a characteristic E-P-R spectrum which identifies its presence and concentration. By further interpreting this spectrum, the scientist can also determine configuration mixing and magnitudes and symmetries of microscopic electrostatic fields at the paramagnetic ion site. An example is shown below.

Number 5 of a series **VANADIUM IONS IN CRUDE OIL**

INTERPRETATION: When Vanadium occurs in crude oils as a trace impurity, it seriously interferes with catalysts used in refining. The quadrivalent vanadium ion has an unfilled electronic shell which causes it to be paramagnetic. Hence it is readily detected and identified by E-P-R. No sample preparation is required.

The spectrum recorded below reveals the strong spin-orbit (L·S) coupling as well as the isotropic hyperfine (I·S) coupling to the $(I = 7/2)$ V^{51} nucleus. Both of these interactions are comparable here, and serve to make the spectrum appear quite complex. Because of this complexity, the presence of other valence states cannot be ruled out without further analysis at another microwave frequency.


CRUDE OIL
Sample volume : 0.16 ml
Microwave power : 125 mw
Audio gain : x100 - 4
Modulation : H-6-200
Integrating time : ½ sec.
ν₀ = 9500 Mc/sec.
H₀ ≃ 3400 gauss

For full technical details on E-P-R and N-M-R Spectroscopy and Spectrometers, write to the Varian Associates Instrument Division

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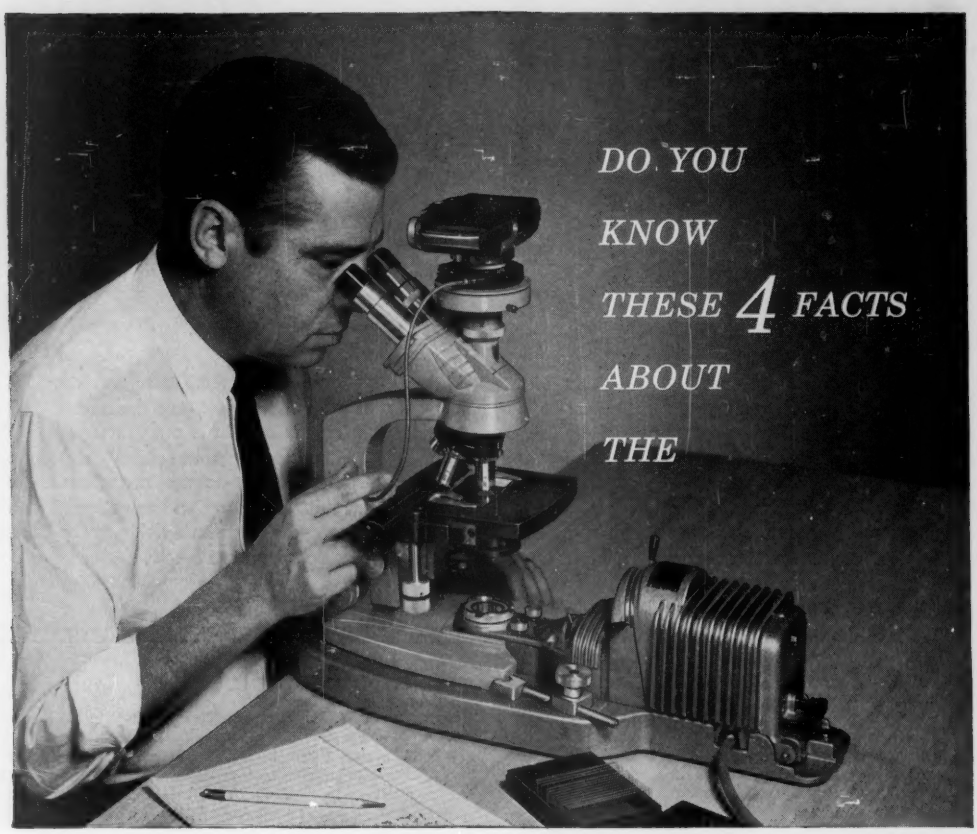

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